ROHDE&SCHWARZ

DOCUMENTATION

SYNTHESIZED MICROWAVE

SIGNAL GENERATOR

MODEL 309

MP MASTER
MA20520

ROHDE & SCHWARZ INC., 4425 NICOLE DRIVE, LANHAM, MD 20706

TEL: (301) 459-8800 TWX: 510-223-0414 FAX: (301) 459-2810

INSTRUCTION MANUAL

SYNTHESIZED MICROWAVE

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REQUEST FOR MAINTENANCE

FROM:

COMPANY NAME _____ **DATE:** _____

ADDRESS: _____ **INDIVIDUAL** _____

_____ **POSITION** _____

SECTION OR DIVISION _____ **PHONE NO.** _____ **EXT.** _____

EQUIPMENT _____ **DATE OF PURCHASE** _____

MODEL _____ **SERIAL NO.** _____ **ORDER NO.** _____

TROUBLE REPORT:

A. Description of trouble _____

_____

_____

_____

_____

_____

B. Has trouble been localized? _____ **If so, how and where:** _____

_____

_____

_____

_____

_____

C. Instruments used and measurements taken, if any: _____

_____

_____

_____

D. Is trouble intermittent? _____

E. Hours of operation prior to this trouble _____

F. Date trouble occurred _____

G. Was factory consulted by telephone or letter prior to this request? _____

If so, give date and person to whom directed: _____

_____

H. Additional Comments: _____

_____

_____

_____

_____

_____

_____

When trouble develops requiring factory assistance, complete this form and send to:

ROHDE&SCHWARZ

Rohde & Schwarz, Inc. 4425 Nicole Drive, Lanham, MD 20706

TEL. (301) 459-8800 TWX: 510-223-0414 FAX: (301) 459-2810

After this report has been analyzed by the Service Department, you will be notified when a field service engineer will call on you to make the necessary repairs. If your trouble can best be corrected at the factor we will so notify you with instructions and authorization for returning the equipment.

NO EQUIPMENT MAY BE RETURNED TO THE FACTORY WITHOUT WRITTEN AUTHORIZATION

REGISTRATION FOR EXTENDED

INSTRUMENTATION

Warranty

ROHDE&SCHWARZ

We warranty the following instrument Model #_____ serial #_____ to be free of defects in materials and workmanship.

We will service, repair and adjust as required said instrument which proves defective within _____ year(s) after date of delivery and which is returned to our factory (or other authorized depot) for that purpose.

The items listed below are considered maintenance items and are excluded from the extended portion (beyond the first year) of the warranty.

For warranty information or other assistance, please contact our Customer Service Department in Lanham Maryland or an authorized regional service depot.

No other warranty is expressed or implied. No liability is assumed for consequential damages.

Items _____
_____
_____
_____

ROHDE&SCHWARZ

4425 Nicole Drive
Lanham, MD 20706

Tel. (301) 459 8800
Fax (301) 459 2810

INSTRUMENTATION

Warranty

ROHDE&SCHWARZ

We warranty each new instrument to be free of defects in materials and workmanship.

We will service, repair and adjust as required any instrument which proves defective within one year after date of delivery and which is returned to our factory (or other authorized depot) for that purpose.

For warranty information or other assistance, please contact our Customer Service Department in Lake Success, New York, or an authorized regional service depot.

No other warranty is expressed or implied. No liability is assumed for consequential damages.

4425 Nicole Drive
Lanham, MD 20706
Tel: 301-459-8800
TWX: 510-223-0414

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Figure 1-1. Synthesized Microwave Signal Generator Model 309

SECTION I

INTRODUCTION

1-1. SCOPE OF MANUAL

1-2. This manual contains information relating to the operation of Synthesized Microwave Signal Generator Model 309 (Figure 1-1), manufactured by Rhode & Schwarz, Inc, Lanham, Maryland. The manual includes a general description of the unit, installation procedures, operating instructions, theory of operation, maintenance procedures, and a replaceable parts list.

1-3. PURPOSE AND USE OF THE INSTRUMENT

1-4. The frequency range of the Model 309 is 10.0 GHz to 18.0 GHz. The maximum calibrated output is at least 10 mw throughout its frequency range. The calibrated output range of the instrument is +10 dBm to −110 dBm with 0.1 dB resolution.

1-5. Typical uses of the instrument are testing broad- and narrow-band microwave systems and components such as attenuators, amplifiers, antennas, radars, receiver sensitivity, frequency dial calibration and other devices. Another application is the use as a local oscillator for frequency converters. The instrument can be operated manually or via IEEE 488 Bus for automatic test systems.

1-6. GENERAL DESCRIPTION

1-7. The Model 309 Synthesized Microwave Signal Generator is a high precision microprocessor controlled solid state instrument incorporating state-of-the-art design. Crystal controlled frequency with microprocessor controlled level output coupled with calibrated AM, FM, and PULSE modulation, make it particularly suitable for the measurement of receiver or component characteristics. Excellent VSWR characteristics of the output chain ensure consistent operation over the full range of the attenuator. Front panel control of RF output level is either via data pad or spin wheel. A four digit LED display can be selected to read in dBm, mV, or μV. An RF-OFF switch reduces the output to +0 −110 dBm in OFF position. In ON position the RF output returns the RF level to the original value or newly selected value. In applications where the generator will be remote from the test set, external leveling with a remote directional coupler can be used to flatten cable frequency response and eliminate amplitude variations due to cable flexing. The instrument will add only ±0.2 dB to flatness of the external detector/coupler used in the test. The top and bottom covers of the unit are solid for rack mounting. The two side covers are perforated to allow heat built up in the unit during standard operation to be vented by forced air, circulated by a fan attached to the rear panel.

1-8. BUS COMPATIBILITY

1-9. The generator is totally BUS controllable through a 488-IEEE/IEC compatible connector located on the rear panel of the instrument. In addition to controlling all of the functions of the generator, the controller is able to interrogate the unit for address and generator malfunction.

1-10. EQUIPMENT SPECIFICATIONS

1-11. Table 1-1 lists the equipment specifications of Synthesized Microwave Signal Generator Model 309.

TABLE 1-1. EQUIPMENT SPECIFICATIONS

Characteristic	Specification
SYNTHESIZED MODE	
Frequency Characteristics	
Range	10.0 to 18.0 GHz
Readout	8 Digits LED
Overrange	9900001 kHz to 18091999 kHz
Resolution	1 kHz
Time Base	
Internal	
Standard (Accuracy)	10 MHz, 10^{-6}
Option 001 (Aging-Standby Power Applied For 30 Days)	10 MHz, 10^{-9}/Day *
External	
Input Level	⩾ –20 dBm
Input Frequency	10 MHz
Output Accuracy	Same as Time Base
Capture Range	10 MHz ± 50 Hz
Reference Output	10 MHz, TTL
Switching Time Max. (From 488 BUS)	60 msec
Spectral Purity	
Harmonic Spurious	⩽45 dBc
Non-Harmonic Spurious	⩽60 dBc *
Sideband Phase Noise	
@ 10 kHz	–80 dBc/Hz *
@100 kHz	–95 dBc/Hz
Power Line Related Spurious	
<300 Hz From Carrier	⩽30 dBc
>300 Hz From Carrier	⩽40 dBc
Fan Rotational Sideband Phase Noise	⩽30 dBc
NOTES: 1. Spectral Purity is independent of external reference oscillator for spurious over 1 kHz. 2. Spurious specification is for CW	
R.F. Level Characteristics	
Output Level	+10 dBm to –110 dBm
Readout	3½ digit LED Display in dBm or mv/μv
Overrange	Additional power available depending on particular unit
Resolution	0.1 dB
Output Accuracy (Over Temperature Range of +10°C to +40°C)	
+ 10.0 dBm to – 10 dBm	±1 dB *
– 10.1 dBm to – 40 dBm	±1.5 dB *
– 40.1 dBm to –100 dBm	±2 dB *
–100.1 dBm to –110 dBm	±2.5 dB *
Level Switching Time	⩽20 msec

*See note page 1-7 for Government Specifications.

TABLE 1-1. EQUIPMENT SPECIFICATIONS (Cont'd)

Characteristic	Specification
Remote Control	≤20 msec
Output Impedance	50 ohms, nominal
VSWR	≤2.0:1
Reverse Power Max.	
Average	2W
Peak	2KW/1 μsec *
Monitor Output (On Rear Panel)	−30 dBm Typical
MODULATION CHARACTERISTICS	
Amplitude Modulation	
Internal	1 kHz Squarewave ±1%
External	
Depth	0 to 70% *
Input Signal Amplitude Required For Calibrated Depth of Modulation	2V peak to peak (0.707 Vrms)
Calibration Accuracy (10 to 70% Mod. Depth)	25% of Selected Modulation Depth Example Selected Mod. Depth: 10% / 50% / 70% Actual Mod. Depth: 7.5 to 12.5% / 37.5 to 62.5% / 52.5 to 87.5%
Frequency Of Modulation	10 Hz to 100 kHz *
Waveshape	Sinewave
Resolution	1%
Distortion @ 1 kHz	≤10% *
Pulse	
Internal	
Rate	0.01 to 0.1 kHz in 0.001 kHz steps* 0.1 to 10 kHz in 0.01 kHz steps 10 kHz to 200 kHz in 1 kHz steps
Accuracy	≤±10%
Width	0.02 μs to 10 μs in 0.01 μs steps* 10 μs to 100 μs in 0.1 μs steps 100 μs to 1000 μs in 1 μs steps
Accuracy	≤±10% ± 25 nsec
Delay	0.1 μs to 10 μs in 0.01 μs steps 10 μs to 100 μs in 0.1 μs steps 100 μs to 1000 μs in 1μs steps 1 ms to 10 ms in 0.01 ms steps
Accuracy	≤±10% ± 15nsec*
External	
Trigger Rate	0.01 to 200 kHz
Trigger Pulse	Direct Coupling, Positive, 10 Hz to 200 kHz, leading or trailing edge*
Trigger Level Output	TTL

*See note page 1-7 for Government Specifications.

TABLE 1-1. EQUIPMENT SPECIFICATIONS (Cont'd)

Characteristic	Specification
Rise and Fall Time	<10 ns *
On/Off Ratio	>80 dB
Video Output	TTL
Frequency Modulation	
Internal	
Rate	0.1 to 10 kHz in 0.01 kHz steps* 10 kHz to 200 kHz in 1 kHz steps
Accuracy	<±10%
Deviation Waveform	Sinewave
Deviation	1 kHz to 999 kHz in 1 kHz steps * 1 MHz to 2 MHz in 10 kHz steps
Maximum Deviation	F. Mod. rate x 10 (Up to 2 MHz)
External	
Input Signal Amplitude Required For Calibrated FM Deviation	2V peak to peak (0.707 Vrms)
Frequency Response	⩽±3 dB (For 100 kHz rate response)
Deviation Waveform	Sinewave
Maximum Deviation	F Mod. rate 8 X 10 (Up to 1.6 MHz) [Usable X10 to 2 MHz]
SWEEP MODE (Wide Deviation, 40 Hz Rate Max.)	
Frequency Characteristics	
Range	10.0 to 18.0 GHz
Resolution	∿1.5 MHz
Maximum Deviation	(18 GHz $-F_C$) or (F_C — 10 GHz) whichever is smaller, in two ranges
Deviation Steps	0 to 995 in 5 MHz steps
Spectral Purity	1 to 4 GHz in 10 MHz steps
Harmonics	⩽45 dBc
Non-Harmonics	⩽60 dBc
Incidental FM	⩽50 kHz peak to peak
Sweeptime	25ms to 100 sec.
Accuracy	⩽±10% Typical
Readout Accuracy	⩽±0.5% ±10 MHz
Frequency Stability	25 ppm/°C ±0.2% of Sweep Width
Frequency Linearity	⩽0.5%
Waveform	Sawtooth with 10ms Dwell Time
Sawtooth Output Level	0 to + 10 volts
RF Output Level Characteristics	
Output Level Range	+10 dBm to −110 dBm
Flatness	⩽±3 dB

*See note page 1-7 for Government Specifications.

TABLE 1-1. EQUIPMENT SPECIFICATIONS (Cont'd)

Characteristic	Specification
Leveling With External Directional Coupler/Detector	
Range	From +7 dBm down to at least −10 dBm depending on coupler
Flatness	±0.2 dB + coupler detector flatness
SWEEP MODE (Narrow Deviation, 200 kHz Rate Max.)	
Modulation Characteristic	
Incidental FM	
Rate	0.1 to 10 KHz in 0.01 kHz steps 10 kHz to 200 MHz in 1 kHz steps
Accuracy	⩽±10%
Resolution	∿ 2MHz
Deviation Waveform	Sinewave
Deviation	1 kHz to 999 kHz in 1 kHz steps 1 MHz to 10 MHz in 10 kHz steps
Frequency Response	⩽± 3 dB (For 100 kHz, rate reference)
External Output	2V peak to peak (0.707 rms)
Incidental FM	<70 kHz peak to peak
External FM	
Input Level	2V peak to peak (0.707 rms)
Frequency Response	⩽±3 dB (For 100 kHz, rate reference)
Maximum Deviation	10 MHz
Incidental FM	⩽70 kHz peak to peak
Output Flatness	⩽±2.5 dB
GENERAL CHARACTERISTICS	
Power Requirements	115/230 VAC ±10%, 50 to 400 Hz, 110 watts
Weight	35 lbs (17 kg)*
Dimensions	5¾ in (14.5 cm) H x 16½ in (42 cm) D x 16¾ in (42.5cm)H
Operating Temperature	0 to 50°C
Programming	Remote IEEE BUS for all functions except POWER "ON". Button for REMOTE/LOCAL provided. Error detection for phased locked loops and power supplies provided on BUS

*See note page 1-7 for Government Specifications.

1-12. ACCESSORIES SUPPLIED

1-13. Table 1-2. lists the accessories supplied with the Model 309.

TABLE 1-2. ACCESSORIES SUPPLIED

Name	Part No.
Instruction Manual	
Power Cable	B160833
¾ Amp Fuse	518123
1½ Amp Fuse	518251

1-14. OPTIONS

1-15. **Option 01: 10 MHz Crystal Oven Time Base.** The 10 MHz Crystal Oven Time Base (Figure 1-2) provides a very stable crystal oven assembly for a 10 9 part/day variation, after a 30 day warm-up.

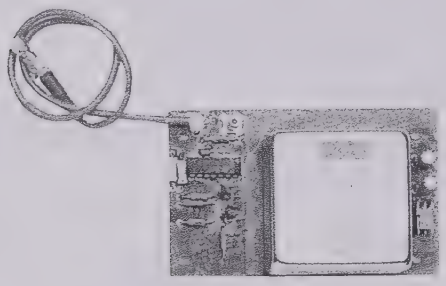


Figure 1-2. 10 MHz Crystal Oven Time Base

1-16. **Option 02: Bucket Extender Card.** The Bucket Extender Card (Figure 1-3) allows easy troubleshooting of boards located in the bucket assembly.

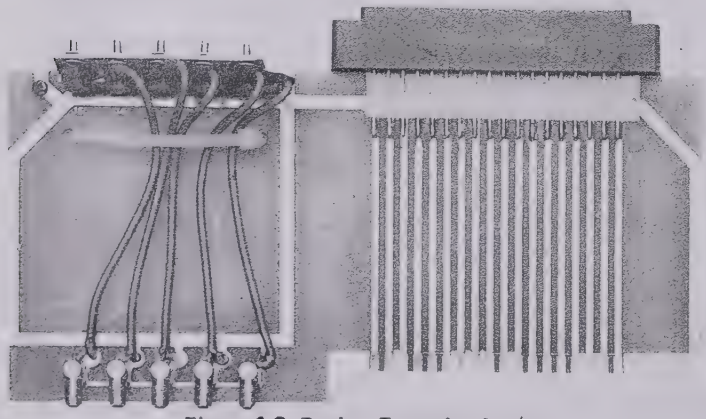


Figure 1-3. Bucket Extender Card

1-17. **Option 03: Troubleshooting Card.** The troubleshooting card (Figure 1-4) in conjunction with a resident program provides a means to troubleshoot the bucket assembly.

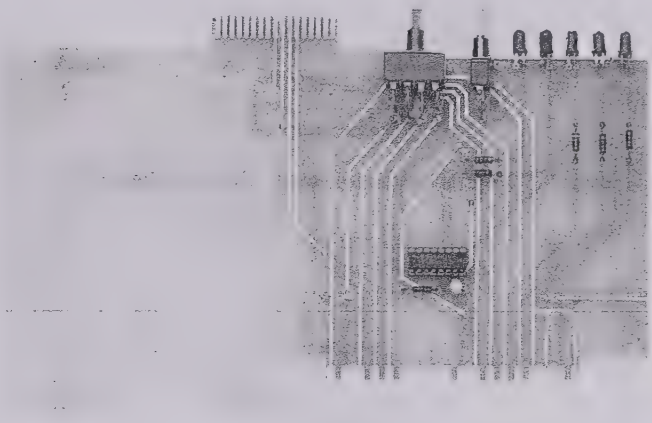


Figure 1-4. Troubleshooting Card

1-18. **Option 04: Rack Mounting Brackets.** The Rack Mounting Brackets allow the mounting of the instrument into a common rack.

1-19. **Option 05: Transit Case.** The Transit Case provides protection for the instrument while hand carrying, shipping, or storage.

NOTE: The following specifications apply to Navy Purchase Description N00109-86-R-UK26 and supercede specifications listed in Table 1-1.

Time Base Stability	10 MHz $\pm 10^{-9}$/hour after one hour warm-up (30 day standby)
Non-Harmonic Spurious	$\leqslant$–55 dBc
Sideband Phase Noise @ 10 kHz	$\leqslant$–65 dBc
Level Accuracy	±2.5 dB of the actual measured output level, +10 to –110 dBm
Reverse Power Protection	100W/μs peak
Depth of Modulation	At least 0 to 70%
Distortion	Less than 10% @ 50% depth and 1 kHz rate
Internal Pulse Rate	100 Hz to 50 kHz
Internal Pulse Width	0.1 to 10 μs
Pulse Delay Accuracy	20%
External Pulse & Sync Rate	10 Hz to 50 kHz
Rise and Fall Time	<50 ns
Internal & External FM Rate	100 Hz to 50 kHz
Internal & External FM Deviation	At least 1 MHz peak (locked or unlocked)
Frequency Accuracy	Indicated frequency shall be ±1 kHz plus measured offset of timebase when measured on external counter
Residual FM (Locked CW) 50 Hz to 15 kHz Detection BW	<1.0 kHz peak
Flatness	±1.0 dB measured at +10 dBm
AC Input Power	$\leqslant$200 watts
Calibration Interval	9 months

SECTION II

OPERATION

2-1. GENERAL

2-2. The Model 309 Synthesized Microwave Signal Generator is shipped complete and ready to operate. No special or permanent installation procedures are required. The instrument should be unpacked upon receipt, observing the usual precautions customary when unpacking an electronic instrument.

2-3. INSTALLATION

2-4. The Model 309 may operate in any position. For ease of operation and to facilitate reading the displays, it is best to tilt the instrument slightly. For this purpose the special tilt stand, which is part of the front feet, should be used. Model 309 is designed for operation at an ambient temperature of 0°C to +50°C. The instrument should be placed so that the rear panel of the instrument is free of obstructions to allow for the intake of air to the fan and the heat dissipation from the fins of both heat sinks. The ventilation holes on the sides of the instrument must not be obstructed to allow for proper ventilation. Model 309 can be rack mounted in 19 inch racks with the use of Option 04, Rack Mounting Brackets.

NOTE

Model 309 is designed for operation with ac voltages of 110V and 220V ±10% and frequencies of 50 Hz to 400 Hz. The instrument is factory adjusted for operation at 110V, but is readily adaptable for use at 220V by replacing the 1.5 amp SLO-BLO fuse with a 0.75 amp SLO-BLO fuse and setting the LINE SELECTOR switch to 220V. The fuseholder and LINE SELECTOR switch are located on the rear panel of the instrument (Fig.2-3).

CAUTION

Always verify that an uninterruptible ground runs from the main power source to the chassis of the generator and to any other instrument connected to it. This is necessary to avoid a potential shock hazard to the operator and to avoid damage to any instrument attached to the generator.

2-5. BUS INTERFACE

2-6. The Bus interface utilizes a standard IEEE 488 Bus cable which mates with the standard 24 pin IEEE STD 488-1978 connector shown in Figure 2-1 and located on the rear panel of the instrument. All inputs and outputs are TTL compatible.

NOTE

The interface BUS cable will not interfere with the hardware if the cable exits from one side or straight out from the rear panel.

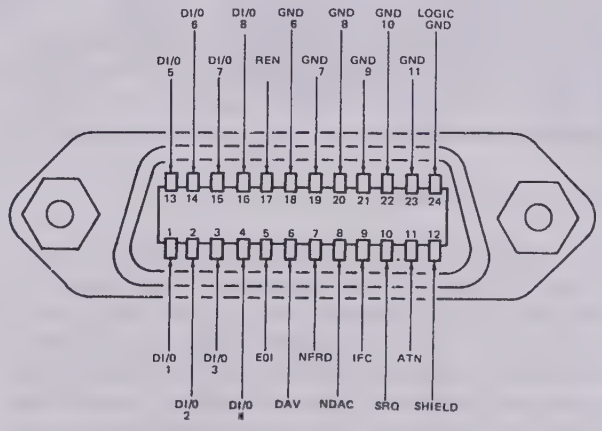


Figure 2-1. IEEE STD 488-1978 Connector

2-7. ADDRESS

2-8. The generator ADDRESS is factory set to decimal 29. To change the address, remove the top cover and locate the ADDRESS switches (Fig. 2-2) adjacent to the front panel., The ADDRESS switches are read only during front panel countdown. After changing the address, set the POWER switch to its "off" position and then to its "on" position or momentarily short the two wires protruding from the Address Switch Board. To set the address refer to Table 2-1. During countdown, the MODULATION display will indicate the set address. If it is correct, replace the top cover.

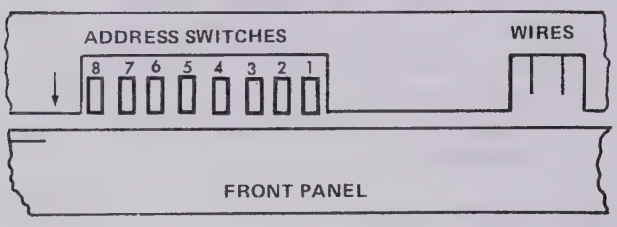


Figure 2-2. ADDRESS Switches

2-9. OPERATING PROCEDURES

2-10. The Model 309 has a frequency range of 10.0 GHz to 18.0 GHz. The maximum calibrated output level is +10 dBm, variable in 0.1 dB steps down to −110 dBm. The instrument has a complete built in pulse generator, AM modulator and FM modulator. When used in the sweep mode, the microwave oscillator is unlocked and a sawtooth waveform sweeps the oscillator with a deviation set via the front panel.

2-11. **OPERATING CONTROLS, INDICATORS, AND CONNECTORS.** The operating controls, indicators, and connectors of the Model 309 are listed in Table 2-2 and shown in Figure 2-3.

2-12. FRONT PANEL

2-13. The front panel is divided into five control groups to ease setting of all the parameters. These groups are; Data Input Group, Frequency Group, Level Group, Modulation Group, and Sweep Mode Group. All parameters are entered via the DATA INPUT keys. The RESOLUTION control can increase or decrease frequency, output level or modulation by being rotated either clockwise or counterclockwise.

TABLE 2-1. DECIMAL ADDRESS CODE

Decimal Code	Address Switches 8	7	6	5	4
0	0	0	0	0	0
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0
11	0	1	0	1	1
12	0	1	1	0	0
13	0	1	1	0	1
14	0	1	1	1	0
15	0	1	1	1	1
16	1	0	0	0	0
17	1	0	0	0	1
18	1	0	0	1	0
19	1	0	0	1	1
20	1	0	1	0	0
21	1	0	1	0	1
22	1	0	1	1	0
23	1	0	1	1	1
24	1	1	0	0	0
25	1	1	0	0	1
26	1	1	0	1	0
27	1	1	0	1	1
28	1	1	1	0	0
29	1	1	1	0	1
30	1	1	1	1	1
31	1	1	1	1	1

2-14. Any function data can be updated by first pressing one of the RESOLUTION arrows, setting the red indicator light over the digit to be modified and rotating the RESOLUTION control either clockwise or counterclockwise. The red indicator light can be set to an "invisible" position to the right of the 0.1 dB steps or to the left of the GHz digit, to avoid any parameter modification due to the wrongful rotation of the RESOLUTION control. To rectify any data entered into the DATA INPUT keys, press the CLEAR key and reenter the data.

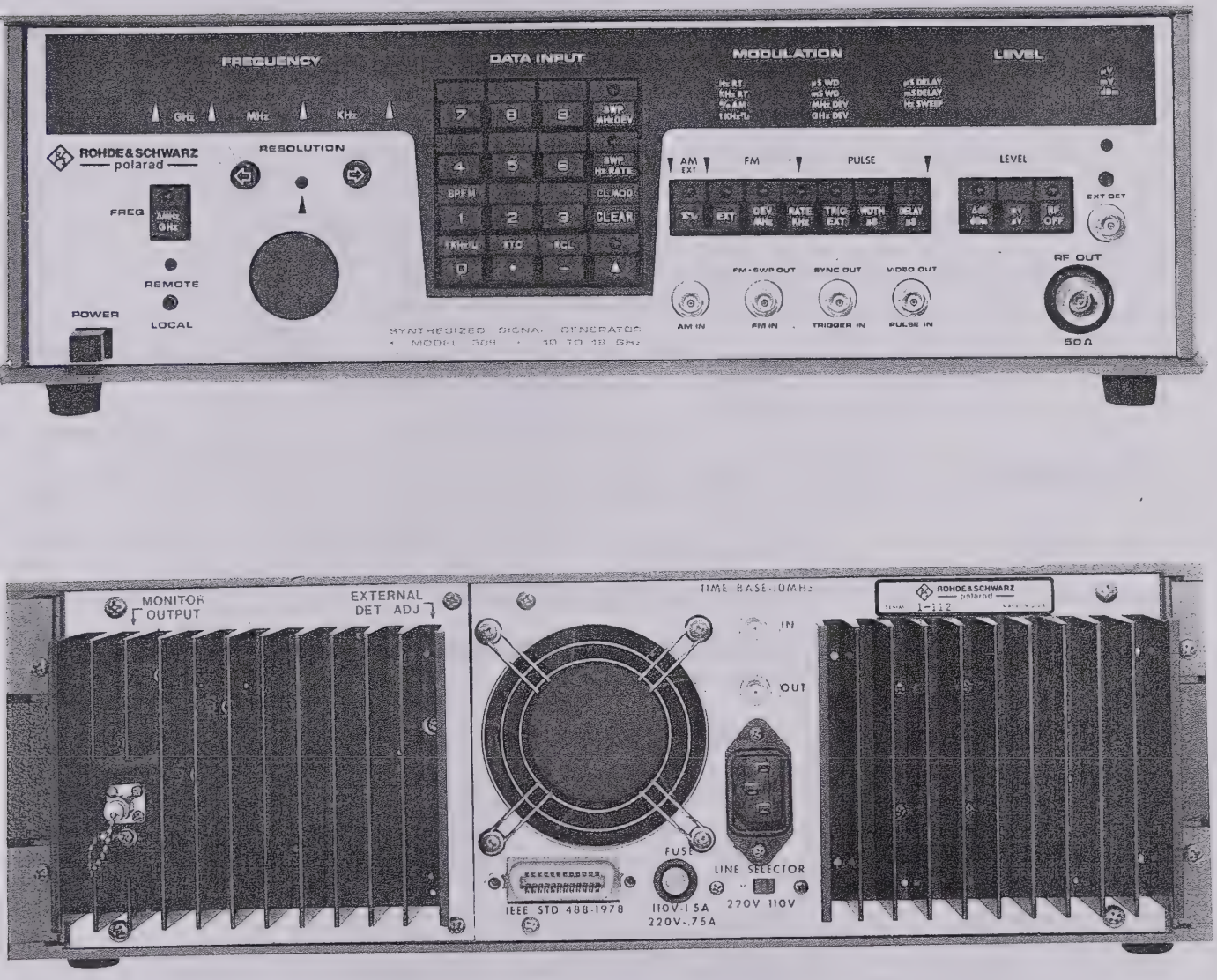


Figure 2-3. Operating Controls, Indicators, and Connectors

TABLE 2-2. CONTROLS, INDICATORS, AND CONNECTORS

Controls, Indicators, and Connectors	Function
FREQUENCY indicator	LED display indicates frequency of the RF output. Decimal point in display is fixed.
MODULATION indicator	Three LED groups indicate modulation parameters being used. Hz RT. . . . . .Rate in Hz kHz RT. . . . .Rate in kHz %AM. . . . . .AM depth of modulation in percent 1K Hz⌝⌞ . . . .1 kHz square wave indication μS WD. . . . . .Indicates pulse width in microseconds mS WD . . . . .Indicates pulse width in milliseconds MHz DEV . . .Indicates FM deviation in MHz GHz DEV . . .Indicates FM deviation in GHz μS DELAY. . .Indicates pulse delay in microseconds mS DELAY . .Indicates pulse delay in milliseconds Hz SWEEP. . .Indicates sweep rate
LEVEL indicator	LED display indicates the sign and level of the RF output signal in dBm from −110 to +10 or its equivalent in mV or μV.
EXT DET indicator	When lit, indicates that the EXT DET function is on.
EXT DET switch	Controls output of EXT DET connector.
EXT DET connector	External detector, with negative output, is connected here to control and level the internal attenuator.
RF OUT connector	Connection for RF output from 10 to 18.0 GHz
LEVEL switches	Three switches to control level in the instrument. RF OFF . . . .RF level is switched to minimum output (−110 dBm) mV/μV . . . . .Selects level unit. (For mV, ▲ key should be pressed first.) Δdb/dBm. . . .Selects level unit. (For any level step, use ▲ key first.)
PULSE switches	Three switches to control pulses in the instrument. WIDTH μS. . .Enters pulse width in microseconds DELAY μS. . .Enters pulse delay in microseconds TRIG EXT. . .Connects input pulse circuit to SYNC OUT/TRIGGER IN connector
FM switches	Three switches that control FM in the instrument. RATE KHz . .Enters internal rate for pulse or FM DEV MHz . . .Enters deviation of FM in MHz. EXT . . . . . .Controls the rate of the FM signal by signal injected into the FM-ΔF OUT/FM IN connector
AM EXT %~ switch	Enters depth of modulation for signal at AM IN connector.

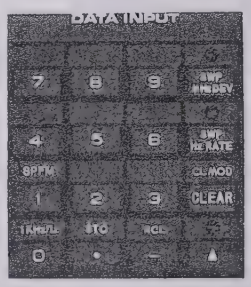
TABLE 2-2. CONTROLS, INDICATORS, AND CONNECTORS (Cont'd)

Controls, Indicators, and Connectors	Function
VIDEO OUT/PULSE IN connector	When an internal pulse is used, a pulse similar to the one used internally to modulate the RF output is available at this connector. If external pulse is used, set to CW and connect a pulse signal to the connector.
SYNC OUT/TRIGGER IN connector	Trigger pulse for delay measurement when an internal pulse is used. When an external pulse is used, press TRIG EXT switch and inject a TTL signal.
FM ΔOUT/FM IN connector	Connection for internal FM. The output will be the rate signal of 2 volts peak-to-peak with a 600Ω load. When an external rate signal is used, press FM EXT key and connect a 2 volt peak-to-peak signal from a 600Ω source. When sweep mode is used, the sawtooth rate signal from 0 volt to 10 volts and a dwell time of 10 ms will appear at the connector.
AM IN connector	To AM modulate, connect a modulation signal of 2 volts peak-to-peak from a 600Ω source to the connector.
RESOLUTION control	Adjusts frequency, modulation, or level
RESOLUTION switch	Positions the indicator over the digit to be changed by the RESOLUTION knob.
ΔMHz/GHz switch	Enters frequency data
REMOTE indicator	Illuminates when the instrument is controlled by the IEEE 488 BUS.
REMOTE LOCAL switch	Returns control to the front panel.
POWER switch	Controls application of ac power.
DATA INPUT keys	Controls data inputs into instrument 1 – 9 . . . . . .Selection of numerical value to be entered for frequency, level, or modulation. SWP MHz DEV . .Deviation for sweep mode. SWP Hz RATE . .Rate for sweep mode CL MOD . . . . . .Disables all modulation when used with ▲. CLEAR . . . . . .Clears all data being entered. ▲ . . . . . .Activates second level functions on keys. Illuminates when in use. – . . . . . .Enters negative numbers. RCL . . . . . .Recalls all previously stored data when used with ▲. • . . . . . .Used to enter frequency or fractional level. STO . . . . . .Stores all data in front panel when used with ▲. 0 . . . . . .Zero digit 1 KHz ⊓ . . . . . .Modulate RF signal at 1 kHz with a square wave signal when used with ▲.
TIME BASE – 10 MHZ IN connector	10 MHz in connector

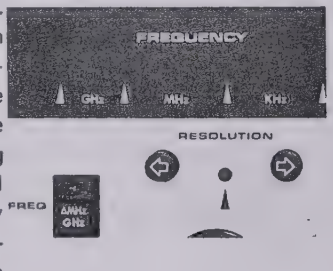
TABLE 2-2. CONTROLS, INDICATORS, AND CONNECTORS (Cont'd)

Controls, Indicators, and Connectors	Function
TIME BASE – 10 MHZ OUT connector	10 MHz out connector
LINE SELECTOR 220/110V switch	Selects either 220v or 110v ac input
FUSE	Circuit protection. 1.5 amp for 110v or 0.75 amp for 220v
IEEE STD 488-1978 connector	Connector for IEEE 488 BUS
Ac input connector	Ac power input connector
MONITOR OUTPUT connector	Rf output connector
EXTERNAL DET ADJ control	Adjustment for levelled output.

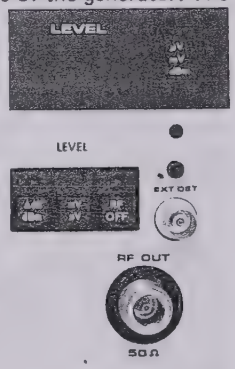
2-15. **DATA INPUT GROUP.** This group of keys allows the entering of data for all of the generator parameters. Data is normally entered first via the key pad, followed by the desired function. The key pad has 10 digits to enter numeric values. The minus (–) key is used for attenuation values lower than 0 dBm, for decreasing frequency or level steps, or trailing edge of a trigger pulse. The dot (•) key is used when entering decimal values. Four extra functions can be entered into the generator by first pressing the ▲ key followed by the key function. These are the 1 KHz ⌜⌞ , STO, RCL, CLR MOD, and SPFM keys.



2-16. **FREQUENCY GROUP.** The FREQUENCY indicator and the ΔMHz/GHz switch are located on the top left of the front panel. The display indicates the RF frequency set in the generator. When the POWER switch is in its on position, a series of self-checks designed to check the general performance of the generator is displayed. Pressing the ΔMHz/GHz switch will enter the desired frequency and by rotating the RESOLUTION control will position the red indicator light over the digit to be changed. If other than decade steps are needed, enter the steps in MHz, press the shift ▲ key, and then press the ΔMHz/GHz switch as many times as required. To decrease the frequency, press the minus (–) key before entering the step. If data outside the limits are being entered, the display and setting will be the closest permissable frequency.



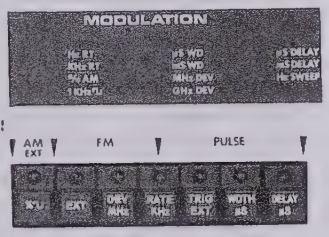
2-17. **LEVEL GROUP.** The LEVEL indicator and LEVEL switches are located on the right side of the generator. The display shows the level in volts or dBm depending on the LED illuminated. Three keys control the display. the ΔdB/dBm key enters the data in dBm, if the data is under –110 dBm, the level will be set to –110 dBm; if the level is greater than the maximum output of the generator at that particular frequency, the display will blink and the level will remain at the previous setting until valid data is entered. If the RESOLUTION control is used, then back down the level until the indicator does not blink. At that point, the setting of the level is the one displayed on the front panel and is the maximum possible level. Step levels, other than decade, can be entered using the ΔdB/dBM key. Select the data in the key pad and press the ▲ key. Then press the ΔdB/dBm key. Each stroke will change the level of the data entered. For step down levels, press the minus (–) key before entering data.



2-18. Levels can be entered in volts, but the level set will

be the closest dB calibration. Any level can be read in volts or dBm by pressing the corresponding keys. To enter mv, press data and ▲ keys and then mV. The RF OFF key will bring the signal levels to <−120 dBm. When RF is off, the LED in the RF OFF key will illuminate. The RF OUT connector is a type N. The connector should be kept clean and connections should be tight to avoid deterioration of the VSWR. When using the generator at low levels, the connections must be tight to cancel any leak through the ground. During warmup the LEVEL display will indicate the number of the software in the instrument. The same display is used during the special test program.

2-19. **MODULATION GROUP.** The modulation group has three displays to show various parameters. The first displays rate in Hz and kHz, AM depth of modulation in percent, and 1 kHz square-wave AM. The second displays width in μs or ms, and deviation in MHz or GHz. The third displays delay in μs or ms and sweep in Hz. The keys below the MODULATION displays are used to enter all modulation parameters. When the key is illuminated, the function is "on". The keys of the modulation groups are: %∿AM, EXT FM, DEV MHZ/FM, RATE kHz/FM, RATE kHz/PULSE, TRIG EXT/PULSE, WIDTH μs/PULSE, DELAY μs/PULSE. Four BNC connectors provide inputs and outputs necessary for the different modulation modes. The connectors are: AM IN, FM-SWP OUT/FM IN, SYNC OUT/TRIGGER IN, and VIDEO OUT/PULSE IN. The functions of the above keys and connectors are explained in Table 2-2.



2-20. **SWEEP MODE GROUP (WIDE BAND).** Two keys (SWP MHz DEV and SWP Hz RATE) are located in the key pad. Sweep deviation is the frequency span between the carrier and the maximum excursion of the frequency. Sweep rate sets the frequency of the modulation.

2-21. **SWEEP MODE GROUP (NARROW BAND).** This group operates with the same keys as in FM modulation, except press the shift ▲ and SPFM keys before setting rate and deviation.

2-22. **MODEL 309 DETAILED OPERATION**

2-23. To operate the Model 309, proceed as follows:

a. Set the POWER switch to its off position.

b. Connect power cable B160833 between the ac input connector of the instrument and the external power source.

c. Push in the POWER switch. All LEDs on the front panel will illumunate indicating that the power is on. Allow the instrument to warm up for one hour.

d. When the POWER switch is in its on position, the program starts a series of self-checks designed to check the general performance of the instrument. The first sequence will illuminate all of the LEDs on the front panel. Any LED not illuminated is defective. The second sequence will indicate in the LEVEL display the revision number of the software contained in the instrument. The MODULATION display will show the IEEE-488 BUS ADDRESS set in the instrument. After that, the instrument will show the number "99" and will start a countdown. When it reaches 0, the program will check the power supplies, loop locks, and power output. If everything is functioning properly, the instrument will automatically set to 10 GHz and −110 dBm. Any malfunction will appear as an error number.

2-24. **CW OPERATION.** For CW operation, proceed as follows:

a. Enter frequency by pressing proper keys in DATA INPUT keyboard. Press the STO/•key before entering MHz data.

b. Press FREQ key. The frequency will be displayed. If frequency data is incorrect, press CLEAR key and re-enter desired frequency.

c. Enter desired level in DATA INPUT keyboard.

d. Select the appropriate LEVEL key (either dBm or mv/μv.

e. Press the RF OFF key to bring the output signal below the −110 dBm level.

2-25. **R.F. FREQUENCY**

To set the rf frequency, select the data and unit.

For 12.0 GHz: [1] [2] Data [ΔMHz GHz] Unit

For 12.2 GHz: [1] [2] [STO •] [2] [ΔMHz GHz]

DATA UNIT

For frequency data outside limits, the output frequency set is the closest frequency to the generator range.

2-26. R.F. LEVEL

To set level output, select data and unit. When the resolution step or the step frequency is larger than the step left of the frequency limits, the entry will be ignored.

For + 8 dBm: [8] [ΔdB dBm]

DATA UNIT

For 8.2 dBm: [8] [STO •] [2] [ΔdB dBm]

DATA UNIT

For −8.5 dBm: [RCL −] [8] [STO •] [5] [ΔdB dBm]

DATA UNIT

For 10.3 mV: [1] [1 KHz L 0] [STO •] [SPFM 3] [▲] [mV μV]

UNIT UNIT

For 8.6 μV: [8] [STO •] [6] [mV μV]

DATA UNIT

For 8.6 μV − dBm (μV expressed in dBm)

Press [ΔdB dBm] Display: −88.3 dBm

2-27. OUTPUT LEVEL

If the LEVEL display blinks, rotate the RESOLUTION control counterclockwise until the blinking stops. That is the maximum level at that frequency. The typical maximum output is shown in Figure 2-4.

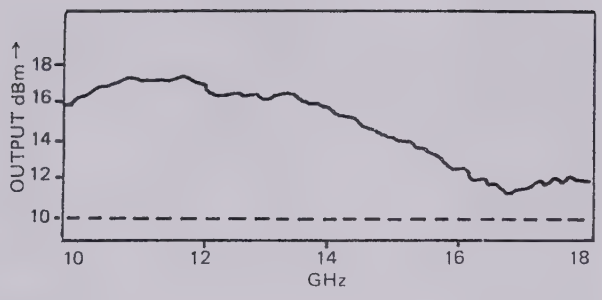


Figure 2-4. Typical Maximum Output

To obtain maximum output at any frequency, press the EXT DET switch. The LEVEL display will indicate UCAL and the RF output will be the greatest power available. Set the EXTERNAL DET ADJ control to the middle of the range. Press the RF switch, the LED will illuminate and the RF output will be ⩽−120 dBm. Press the RF OFF switch again for RF output indicated in the LEVEL display. For level data lower than −110 dBm, the level readout is −110 dBm. For level data higher than the maximum output, the LEVEL display will blink and the output will remain at the previous level until permissable data is entered. The maximum output depends upon level vs. frequency, characteristics, and temperature. The generator is calibrated up to the maximum output. The RESOLUTION control can bring the LEVEL display down until the blinking stops. This level is the maximum output of the unit at that frequency.

2-28. MODULATION

a. **Internal AM**

1 KHz Square Wave [▲] [1 KHz ⌐⌐ 0]

SPECIAL FUNCTION

b. **External AM**

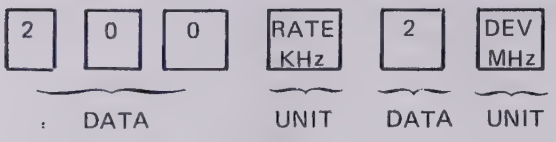
52% depth of modulation, 10 kHz modulation. 10 kHz modulation signal applied to AM IN connector. (Signal level ±1 volt/0.7 vrms, sinewave)

[5] [2] [% ∿]

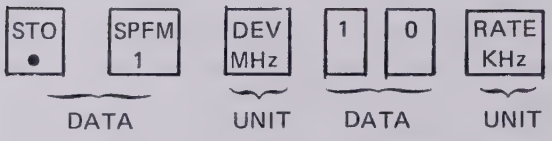
DATA UNIT

c. **Internal FM**

200 KHz rate, 2 MHz deviation from carrier.

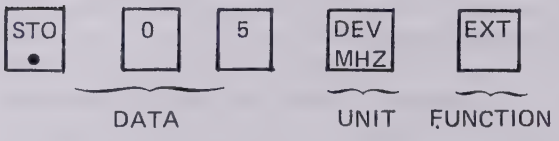


100 kHz deviation from carrier, 10 kHz rate.



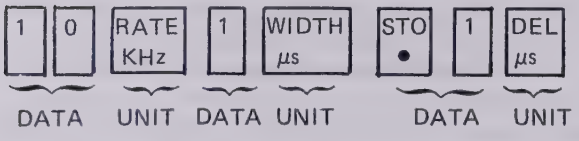
d. **External FM**

20 kHz rate, 50 kHz deviation carrier. 20 kHz modulation signal applied to FM IN connector.

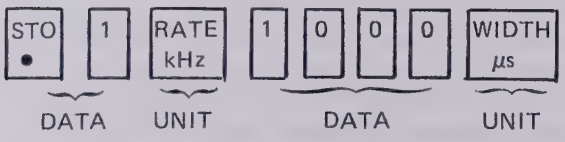


e. **Internal Pulse Rate**

10 kHz rate, 1 μs width, 0.1 μs delay



100 Hz rate, 1 ms rate



SYNC OUT connector. Pulse in phase with internal oscillator.

f. **Internal Pulse, External Trigger**

100 Hz rate, 1 ms width, 1 μs delay. 100 Hz trigger input applied to TRIGGER IN connector.

g. **VIDEO OUT Connector.**

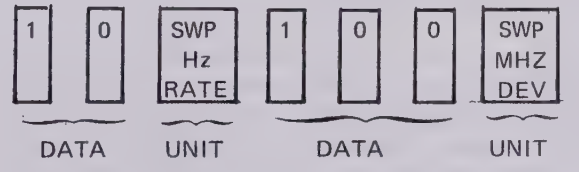
Pulse delayed from SYNC OUT connector.

h. **PULSE IN Connector.**

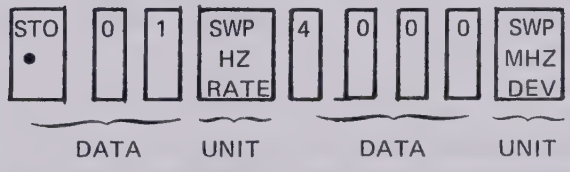
Set the generator to CW (no modulation). Connect external pulse to PULSE IN connector. (Pulse source must have an impedance of < 1000 ohms.)

i. **SWEEP (Unlock Mode) (Wide Deviation)**

10 Hz rate, 100 MHz deviation from carrier.



100 sec. sweep, 4 GHz deviation from carrier.



j. **SWEEP (Unlock Mode) (Narrow Deviation)**

100 Hz rate, 10 MHz deviation from carrier.

If a non-allowed combination is entered, the display will blink.

k. **Some Allowed Modulation Combinations.** (See Table 2-3).

TABLE 2-3. MODULATION COMBINATIONS

FIRST	SECOND									
	AM	FM INT	FM EXT	PULSE INT	PULSE EXT TRIG	PULSE EXT PULSE	SWEEP	1KHz II	SP FM INT	SP FM EXT
AM	–	YES	YES	YES	YES	YES	YES	NO	NO	NO
FM INT	YES	–	NO	YES	YES	YES	NO	NO	NO	NO
FM EXT	YES	NO	–	YES	YES	YES	NO	NO	NO	NO
PULSE INT	YES	YES	YES	–	NO	NO	NO	NO	NO	NO
PULSE EXT TRIG	YES	YES	YES	NO	–	NO	NO	NO	NO	NO
PULSE EXT PULSE	YES	YES	YES	NO	NO	–	YES	NO	YES	YES
SWEEP	YES	NO	NO	NO	NO	YES	–	NO	NO	NO
1 KHz II	NO	NO	NO	NO	NO	NO	NO	–	NO	NO
SP FM INT	NO	NO	NO	NO	NO	YES	NO	NO	–	NO
SP FM EXT	NO	NO	NO	NO	NO	YES	NO	NO	NO	–

TRIPLE COMBINATIONS

AM–INT FM–INT PULSE
AM–INT FM–EXT PULSE TRIG
AM–EXT FM–EXT PULSE TRIG
AM–INT FM–INT PULSE
AM–INT FM–EXT PULSE
AM–EXT FM– EXT PULSE
AM–SWEEP–EXT PULSE

2-29. RESOLUTION FEATURE

2-30. Any parameter value can be modified by using the RESOLUTION control. After entering one or more functions, the red indicator light will be located above the last entry. Clockwise rotation of the RESOLUTION control will increase the data value. Counterclockwise rotation of the RESOLUTION control will decrease the data value. Data value modification will stop when frequency data outside the limits of the generator are entered. In the level output function, the data value will stop when the minimum value is reached (E1 = –110 dBm) or, at the upper end, it will continue increasing after the maximum value is reached, but the indicator will blink continuously The maximum value that is displayed is 18. If the RESOLUTION control is rotated in a counterclockwise direction, the data value will decrease and the indicator light will continue to blink until the maximum output level at that frequency is found. For modulation, when an entry outside the limit of the generator is attempted by using the RESOLUTION control, the setting will remain as before but the display will show the first entry while blinking. A new entry is required via the DATA INPUT keys to erase all modulation. Use the shift (▲) and CL MOD keys before attempting a new entry. The RESOLUTION control is disabled when the indicator light is moved one step to the left of the GHz digit or to the right of the decimal level display.

2-31. STORE/RECALL

2-32. The generator is able to store up to 10 settings of all parameters displayed on the front panel except for VIDEO IN. The following are the steps necessary to store and recall the setting in location 2.

To Store:

After pressing the STO/• key, the FREQUENCY display will momentarily show S ⌐ O and the memory location being used.

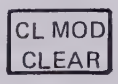
To Recall:

After pressing the RCL/– key, the FREQUENCY display will momentarily show ⌐EC followed by the location being recalled.

2-33. CL MOD/CLEAR

2-34. The CLMOD/CLEAR is used to clear data in-

put after data has been entered and before using a data key. In the upshift mode, it will erase all modulations. Every time the shift ▲ key is pressed, the LED will light, indicating that it is waiting for a function entry. The LED will be extinquished after the entry is made.



2-35. REAR PANEL

2-36. Some input/output functions are located on the rear panel of the generator. The TIME BASE-10 MHz IN and the TIME BASE-10 MHz OUT connectors allow for the synchronization of two or more instruments through the same time base. The TIME BASE-10 MHz IN connector will receive a signal of 10 MHz to lock the generator to an external frequency. The TIME BASE-10 MHz OUT connector has a 10 MHz output signal to lock any external device. The IEEE 488 1978 connector is used to control the unit via a BUS cable driven from a controller(computer). Inside the heatsink is the MONITOR OUTPUT and the EXTERNAL DET ADJ adjustment control used to control the level output when EXT DET is being used.

2-37. REMOTE OPERATION

2-38. The generator can be remotely controlled through the use of the IEEE STD 488 1978 connector on the rear panel. All front panel parameters, excluding the POWER switch can be programmed through a computer via the IEEE 488 BUS standard cable and can communicate in talk or listen mode. When in talk, the front panel controls are inoperative and the REMOTE indicator is illuminated. The generator talk and listen addresses are the same and they are set by the ADDRESS switches (See Fig. 2-2). The correct setting s are described in paragraph 2-7. To display the ADDRESS, turn the POWER switch to its "on" and "off" positions and observe the MODULATION display for the ADDRESS indication. Table 2-4 lists the entire IEEE 488 commands. For all parameters with a value, the sequence of the programs are data-function. The letter "X" in the table indicate data input in units shown between the parenthesis (). To command parameters without data, simply type the command between " ". Commands for PUC computers are as follows: For example, for ADDRESS 29, 12.0 GHz, −1 dBm the program reads IEC OUT 29, "12.0 GHz, −1 dBm".

TABLE 2-4. IEEE 488 COMMANDS

FREQUENCY	(GHz)	"X GHz"
STEP FREQUENCY	(MHz)	"X SF"
LEVEL	(dBm)	"X DM"
LEVEL	(mV)	"X MV"
LEVEL	(μV)	"XUV"
STEP DB	(dB)	"X SD"
RF OFF		"R0"
RF ON		"R1"
dBm mV		"MV"
dBM μV		"UV"
mV dBm		"DM"
μV dBm		"DM"
STORE SETTINGS		"X ST"
RECALL SETTINGS		"X RC"
UNLOCK FM		"UF"
EXT AM	(X%)	"X AS"
INT AM (SQ. WAVE)		"A1"
EXT FM		"EF"
FM DEV	(MHz)	"X FD"
FM RATE	(kHz)	"X CR"
ΔF/DEV	(MHz)	"X DD"
ΔF/SWEEP	(Hz)	"X DR"
PULSE RATE	(kHz)	"X CR"
PULSE WIDTH	(μS)	"X PW"
PULSE DELAY	(μS)	"X PD"
PULSE EXT TRIGGER/+		"PT"
PULSE EXT TRIGGER/−		"−PT"
EXT DET		"ED"
CLEAR MODULATION		"CM"

2-39. APPLICATIONS

2-40. The Synthesized Microwave Signal Generator Model 309 is well suited for applications where high performance signals are required. Simulation for communication receivers and radars are two of the most important applications due to the excellent signal purity and modulation capability. In addition, with the external program control through the use of the IEEE 488 BUS, this unit is a truly portable instrument.

2-41. SATELLITE COMMUNICATIONS

2-42. The Model 309 provides an excellent means to test satellite receivers in the 11.7 to 12.7 GHz range. The 10 MHz FM peak deviation at rates of 100 Hz to 200 kHz is

utilized for this type of measurement and the precision of the attenuator system gives exact and repeatable receiver sensitivity measurements in FM receiver substitution tests. The resolution of 1 kHz per step, allows for a precise frequency necessary to step through adjacent channels. Many modern systems require combined modulations such as pulse and FM or AM and FM and the Model 309 has the capability to modulate internally, externally or combined. All these measurements can be controllable from a central computer interconnected with an IEEE 48 BUS.

2-4 RADAR

2-44. Another very important application of the Model 309 is in the simulation of signals necessary to test modern radar systems. The high performance pulse generator with an internal ON/OFF ratio of 80 dB, Rise and Fall time of 10 ns, and calibrated delay time enables accurate testing of radar receivers. In addition, accurate sensitivity tests can be accomplished because of the high accuracy of the attenuation system that is an integral part of the generator. Various combinations of different types of modulation can be set to check the radar systems.

2-45. LOCAL OSCILLATOR

2-46. The low sideband phase noise of the Model 309 and its high output levels make it an excellent substitute as a local oscillator for frequency converters. The maximum power output of at least +10 dBm will saturate a standard mixer. In the lower frequency range, powers up to +16 dBm are available.

2-47. AUTOMATIC TEST APPLICATIONS

2-48. The Model 309 is ideal for automatic test applications where a program controls several instruments to perform a measurement or task. Figure 2-5 shows the interconnection of instruments to measure the gain and 1 dB gain compression for an output of +22 dBm for an X band microwave amplifier.

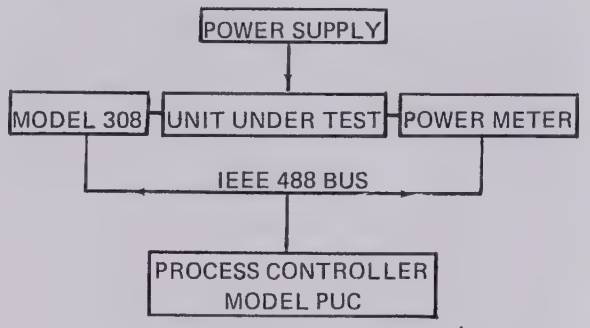


Figure 2-5. Automatic Test Application Setup

The following program is in BASIC for the Rohde & Schwarz-Polarad Process Controller Model PUC. Other computers may require some software modifications.

```
100 PRINT"PROGRAM# 163535-3":REM AMP,MICROWAVE,W/AUTO CORR OF 309 1/22/86
101 IEC_ERR:IECTIME50:IECIN5,K$
102 REM MICRO COMP TEST,POWER METER,     BLOCK#1   ,DISK#335 :    HOLD1000
103 S=29:IECDCL:HOLD3000:GOSUB17000:PRINT"↵"
104 PRINT    "-----------------------------"
105 POKE 37871,130:REM SEL D/A RLYS
110 OPEN2,230
115 IECTIME30
117 TI$="000000"
120 PRINT"**MENU OF 309 MICRO COMP"
125 PRINT    "-------------------------------"
130 PRINT"GROUP #","COMP NAME",
135 PRINT    "-----------------------------"
167 PRINT"  7 ","AMP.,MICROWAVE"
170 PRINT"-----------------------------------"
300 INPUT "SELECT GROUP NUMBER";A1
310 ON A1 GOTO 401,402,403,404,405,406,407,408,409,410,411,412,413
338 PRINT#2,
401 GOTO 500:REM COMP1 SUB
402 GOTO 520:REM COMP2 SUB
```

```
403 GOTO 540:REM COMP 3 SUB
404 GOTO 560:REM COMP 4 SUB
405 GOTO 580
406 GOTO 590
407 GOTO 600
408 GOTO
409 GOTO
410 GOTO 600
411 GOTO
412 GOTO
413 GOTO
600 GOSUB7700:REM COMP#7
602 GOSUB7746
604 GOSUB 5000
606 GOSUB 8000
608 GOSUB 18100
610 GOSUB18200:IF A1=10 THEN GOSUB18400
615 GOSUB8200
620 GOSUB 9700
625 GOSUB 5290
630 GOSUB 10000
635 Z1=18.8:Z2=21.1:GOSUB 8800
638 GOSUB 10100
640 G1=0:G2=25: G1$="0 DB":G2$="25 DB":GOSUB 8900
645 GOSUB 9500
650 GOSUB 10112
655 GOTO 640
1570 PRINT "↓H":G.P
1575 PRINT "HIT(SHIFT)WHEN READY FOR NEXT UUT"
1580 WAIT 152,1
1585 IECOUTS,"GM"
1586 PRINT#2," "
1587 PRINT#2,"-------------------------------------------------------------------------------
1588 PRINT#2," "
1590 RETURN
4000 REM POWER MTR SUB ##################################################################
4010 IEC TIME50
4020 IECSPL13,V%:IF V% <>80 THEN GOTO4020
4025 IECIN13,K$
4030 K$=MID$(K$,4,5):K=VAL(K$)/100
4040 RETURN
5000 REM *** ATT /PWR MTR MEA      ##################################################
5010 REM  SPEED1:REM OPEN2,230
5030 IECOUTS,PA$
5080 DIMJ(170),V(170),W(170),X(170),Y(170),Z(170),G(170),Y$(170),Z$(170)
5085 DIM P(170),C$(170),W1(170),V1(170) ,C(170),V2(170),V6(170)
5090 PRINT"↓H":GOSUB 6060
5095 PRINT "↓H":PRINT"SEE FIG#1"
5100 PRINT"BYPASS UUT TO ZERO TEST SYSTEM."
5110 PRINT"CHECK POWER LEVELS TO ";
5120 PRINT"MAKE SURE ";
```

```
5130 PRINT"SET UP  IS PROPERLY CONNECTED"
5140 PRINT
5150 PRINT"HIT(RETURN)WHEN READY TO START"
5160 GET M$:IF M$= "" THEN 5160
5170 PRINT"CH":PRINT"INPUT POWER BEING CHECKED"
5175 IECOUTS,PA$      : PRINTPA$;"=309 SETTING"
5190 GOSUB6250
5200 GOSUB 5830
5210 PRINT#2,B1$
5215 GOSUB 6245
5220 FOR N=0 TO S2  STEP 5
5230 PRINT#2,J(N);V(N),V(N+1),V(N+2),V(N+3),V(N+4)
5240 NEXT N
5250 PRINT#2,"################### END INPUT POWER ######################"
5260 PRINT#2,
5270 PRINT#2,
5280 REM    GOSUB 6320
5285 RETURN
5290 PRINT"CH"
5300 PRINT"CHECK POWER LEVELS TO MAKE SURE"
5310 PRINT"SET UP IS PROPERLY CONNECTED."
5320 PRINT"IS THE DATA WITHIN ACCEPTABLE LIMITS Y/N"
5330 INPUT E$:IF E$="N" THEN PRINT"CH":PRINT"RESTART PROGRAM":STOP
5333 PRINT"CH":RETURN
5340 REM START IL ######################################################
5350 PRINT"CH"
5360 PRINT"OPERATOR INSTRUCTIONS"
5370 INPUT "COMMENTS";D$
5380 INPUT "UUT S/N";C$
5400 PRINT"                          "
5420 PRINT"                                          "
5430 PRINT"HIT(RETURN)WHEN READY"
5440 GET N$:IF  N$=""THEN5440
5442 PRINT#2,
5443 PRINT#2,
5445 PRINT#2,"UUT S/N";C$
5450 GOSUB 6250
5460 PRINT#2,A4$
5465 GOSUB 6245
5470 GOSUB  5950
5480 FOR N=0 TO S2  STEP 5
5490 PRINT#2,J(N);Z$(N),Z$(N+1),
5495 PRINT#2,Z$(N+2),Z$(N+3),Z$(N+4)
5510 NEXT N
5520 PRINT#2,"############ END ";
5522 PRINT#2,A4$;
5524 PRINT#2," ####################"
5530 PRINT#2,
5540 PRINT#2,
5550 GOSUB 6440
5560 REM  PRINT"DO YOU WANT TO REPEAT THE IL MEASUREMENT  Y/N"
```

```
5570 REM    INPUT E$:IF E$="Y" THEN GOTO 5460
5580 PRINT#2,
5585 RETURN
5590 REM ##########################################################################
5600 GOSUB 6140
5602 GOSUB 6250
5604 GOSUB 6245
5606 GOSUB 5630
5607 RETURN
5630 PRINT"SET NOM ATT AT";
5660 PRINTF1;"MHZ"
5700 FOR N=0 TO   52 STEP5
5710 PRINT#2,J(N);Y$(N),Y$(N+1),
5712 PRINT#2,Y$(N+2),Y$(N+3),Y$(N+4)
5730 NEXT
5740 PRINT#2,"##################### END ATT ##############################"
5750 PRINT#2:PRINT#2:PRINT#2
5760 REM   GOSUB 6570
5770 REM   PRINT"DO YOU WANT TO RETEST ATT Y/N"
5780 REM INPUT E$:IF E$="Y"  THEN GOTO5600
5785 RETURN
5790 PRINT  "CH"
5792 PRINT"DO YOU WANT TO TEST ANOTHER UUT,Y/N"
5794 INPUT E$:E$="Y" THEN STOP
5795 RETURN
5810 PRINT"END OF PROGRAM"
5830 REM ********* MEASURE POWER *********
5840 FOR J=L TO H STEP S1
5850 J$=STR$(J/1000)+"GZ":REM SET FREQ
5860 IECOUT5, J$:   REM SET 309
5865 GOSUB 4000
5900 N=(J-L)/S1
5910 V(N)=K
5920 J(N)=J:REM -50
5930 NEXT J
5940 RETURN
5950 PRINT#2,"TIME=";TI$
5955 FOR J=L TO H STEP S1:REM MEA IL
5960 J$=STR$(J/1000)+"GZ":REM SET FREQ
5970 IECOUT5, J$:REM SET 309
5975 GOSUB 4000
6010 N=(J-L)/S1
6020 W(N)=K
6030 J(N)=J
6032 Z=V(N)-W(N):Z(N)=INT(10*Z+.5)/10
6034 H$="*"
6036 IF Z(N)>Z1 AND Z(N)<Z2 THEN H$=" "
6038 Z$(N)=STR$(Z(N)) +H$
6040 NEXT J
6045 PRINT#2,"TIME=";TI$
6050 RETURN
```

```
6060 REM   PRINT "COMP CHARACTERIZATION"
6070 PRINT
6080 PRINT"OPERATOR INSTRUCTION"
6082 PRINT"SET UP PER FIG#1"
6084 PRINT"**********************************"
6090 INPUT"DATE";A$
6100 INPUT "UUT MODEL #";B$
6110 INPUT "UUT USED ON 300 SERIES MODEL#";D
6120 INPUT  "COMMENTS";D$
6130 RETURN
6140 PRINT#2,"TIME=";TI$
6145 FOR J=L TO H STEP S1:REM MEA ATT
6150 J$=STR$(J/1000)+"GZ":REM SET FREQ
6160 IECOUTS, J$ :REM SET 309
6170 IECOUTA,"CF "+J$+";":GOSUB6840 :IECOUTA,"PP;":GOSUB6840
6180 IECOUTA,"E1;":GOSUB6840 :IECOUT A,"MA;":GOSUB6840
6190 IECINA,K$:K=VAL(K$):GOSUB6840
6200 N=(J-L)/S1
6210 X(N)=K
6220 J(N)=J
6222 Y(N)=W(N)-X(N)
6224 H$="*"
6226 IF Y(N)>Y1 AND Y(N)<Y2 THEN H$=" "
6228 Y$(N)=STR$(Y(N))+H$
6230 NEXT J
6235 PRINT#2,"TIME=";TI$
6240 RETURN
6245 PRINT#2,"F(IN MHZ)          F+";S1;"          F+";2*S1;" F+";3*S1;
6246 PRINT#2,"            F+";4*S1
6248 RETURN
6250 REM PRINT#2,
6255 PRINT#2,L$
6260 PRINT#2,"DATE ";A$
6270 PRINT#2,"UUT MODEL#";B$
6290 PRINT#2,"COMMENTS:";D$
6310 RETURN
6320 REM START GRAPHICS##################################################
6330 REM#########################
6340 REM PWR GRAPHICS ##########################
6350 MIN=5:MAX=15:GOSUB 6700
6360 OPEN 1,230:PRINT#1,CHR$(13):CLOSE1
6370 PRINT "R0   INPUT POWER: 5 TO 15 DB"
6380 G.M,J(0),V(0)
6390 FOR I=1 TO 108
6400 G.L,J(1),V(I)
6410 NEXT I
6420 G.C
6430 RETURN
6440 REM ########## IL GRAPHICS##################
6450 FOR N=0 TO S2
6460 REM  Z(N)=V(N)-W(N)
```

```
6470 NEXT N
6480 MIN=G1 :MAX=G2:GOSUB 6700
6490 OPEN 1,230:PRINT#1,CHR$(13):CLOSE1
6500 PRINT "H" A4$;G1$;" TO ";G2$
6510 G.M,J(1),Z(1)
6520 FOR I=2 TO 110
6530 G.L,J(I),Z(I)
6540 NEXT I
6550 G.C
6560 RETURN
6570 REM ATT GRAPHICS        ######################################
6580 FOR N=0 TO 108
6590 Y(N)=W(N)-X(N)
6600 NEXT N
6610 MIN=0:MAX=100:GOSUB 6700
6620 OPEN 1,230:PRINT#1,CHR$(13):CLOSE1
6630 PRINT "H    ATTENUATION:  0 TO 100DB"
6640 G.M,J(1),Y(1)
6650 FOR I=2 TO 108
6660 G.L,J(I),Y(I)
6670 NEXT I
6680 G.C
6690 RETURN
6700 G.P
6710 REM GRAPH OUTLINE#######################################
6720 G.WIN,10000,18000,MIN,MAX
6730 G.M,10000,MAX:G.L,10000,MIN:G.L,18000,MIN
6740 FOR F=10000 TO 18000 STEP 500
6750 G.M,F,MIN
6760 G.L,F,MIN+1
6770 NEXT F
6780 FOR O=MIN TO MAX STEP .5
6790 G.M,10000,O:G.L,10050,O
6800 NEXT O
6810 PRINT "H":PRINT "#########################"
6820 PRINT "    11   12   13   14   15   16   17  18"
6830 RETURN
6840 HOLD280 :RETURN
7700 HOLD 10:REM COMP 7 SUB**************************************
7702 PRINT#2,"ITEM 7 SEL FROM MENU"
7704 PRINT#2,"AMPLIFIER,MICROWAVE"
7706 PRINT#2,"SPEC CTRL DWG#B163167"
7708 PRINT#2,"TEST SPEC DWG# 163535-7"
7710 L$=  "TEST PROGRAM#163535-2"
7711 PRINT#2,L$
7712 PRINT#2,:PRINT#2,:PRINT#2,
7714 PRINT#2,"TEST EQUIPMENT REQ'D"
7716 PRINT#2,"309, HP#436A,20DB PAD"
7718 PRINT#2,"TEST FIXTURE(OPTIONAL)"
7722 PRINT#2,:PRINT#2,
7724 PRINT#2,"LIST OF TESTS"
```

```
7726 PRINT#2,"NORMALIZE"
7727 PRINT#2,"20 DB PAD CHECK"
7728 PRINT#2,"GAIN,14DB MIN,24DB MAX"
7730 PRINT#2,"FLATNESS,+/-2.0"
7732 PRINT#2,"COMPRESSION,1.0 DB MAX"
7736 PRINT#2,"* INDICATES OUT OF SPEC"
7740 PRINT#2,:PRINT#2,
7742 PRINT#2, "SET UP PER FIG.1"
7744 TI$="000000":RETURN
7746 REM GEN PARAMETERS COMP#7
7748 S=29 :REM 309
7749 B1$="***************** INPUT PWR IN DBM ***************************"
7750 A=13: REM HP 436A
7752 Y1=13.8:Y2=24.2: REM AMP MIN/MAX @ -10 DBM INPUT
7754 L=10000 :REM LOWER FREQ
7756 H=18000: REM UPPER FREQ
7758 S1=100:S2=(H-L)/S1: REM  STEP SIZE
7760 PA$ ="4DM" :REM APPLIED PWR
7777 A4$="***************     20 DB PAD ATT     **********************"
7778 A5$="***************      AMP GAIN @ -10 DBM INPUT ***************"
7780 RETURN
8000 PRINT"CH":PRINT"LEVELED POWER BEING CHECKED"
8001 PRINT"P(N)=309 SETTING,V(N)=LEVELED PWR"
8002 FG=0:REM CORR FLAG
8005 FOR J=L TO H STEP S1:N=(J-L)/S1:  REM ******************
8010 P=2*VAL(PA$)-V(N):REM PWR LEVEL CALC
8015 P(N)=INT(10*P+.5)/10
8110 J$=STR$(J/1000)+"GZ":REM SET FREQ
8120 IECOUTS,J$:  GOSUB 6840
8130 P$=STR$(P(N))
8140 IECOUTS,P$+"DM"
8150 GOSUB 4000
8160 V(N)=K:J(N)=J
8165 IF V(N)>3.92 AND V(N)<4.08 THEN GOTO   8175
8167 PRINTJ:P(N)=(4-V(N))+P(N):P(N)=INT(10*P(N)+.5)/10:FG=FG+1
8168 IF FG>3 THEN 8172
8170 GOTO 8130
8172 PRINT#2,"CAN'T LEVEL @ ";J;" MHZ.AFTER 3 TRIES"
8175 FG=0: NEXT J
8180 GOSUB 5210:REM PRINT LEVELED PWR
8182 RETURN
8190 RETURN
8200 IECOUTS,"10DM":GOSUB 6840:REM  RAW PWR @ 10DBM
8202 PRINT"CH":PRINT"RAW 10DBM PWR MEA=V1(N)":BEEP500
8205 FOR J=L TO H STEP S1
8210 J$=STR$(J/1000)+"GZ"
8215 IECOUTS,J$ : N=(J-L)/S1:GOSUB 6840
8220 GOSUB 4000
8230 V1(N)=K
8235 NEXT J
8240 RETURN
```

```
8800 IECOUTS,"10DM":GOSUB 6840:REM PAD ATT @ 10DBM ****************
8802 FOR J=L TO H STEP S1
8805 J$=STR$(J/1000)+"GZ":REM SET FREQ
8810 IECOUTS,J$:N=(J-L)/S1:GOSUB 6840
8822 GOSUB 4000
8824 N=(J-L)/S1
8828 W(N)=K
8830 J(N)=J
8832 Z=V1(N)-W(N):Z(N)=INT(10*Z+.5)/10
8834 H$="*"
8837 IF Z(N)>Z1 AND Z(N)<Z2THEN H$=" "
8838 Z$(N)=STR$(Z(N)) +H$
8839 NEXT J
8840 PRINT#2,A4$
8845 GOSUB 6245
8850 FOR N=0 TO S2  STEP 5
8855 PRINT#2,J(N);Z$(N),Z$(N+1),Z$(N+2),Z$(N+3),Z$(N+4)
8860 NEXT N
8865 PRINT#2,"#################### END 20DB PAD PWR ######################"
8867 REM GOSUB 6440
8868 G.P:PRINT"CH"
8870 RETURN
8900 YA=500 :YB=-500:PRINT"CH","AMP GAIN @ -10DBM INPUT"
8903 FOR J=L TO H STEP S1:REM AMP GAIN @ -10 DBM
8905 J$=STR$(J/1000)+"GZ":REM SET FREQ
8910 IECOUTS,J$:N=(J-L)/S1:GOSUB 6840
8915 P$=STR$(P(N)-14)
8920 IECOUTS,P$+"DM"
8922 GOSUB 4000
8924 N=(J-L)/S1
8930 J(N)=J
8932 Y=K-W1(N)+VAL(Z$(N)) :Y(N)=INT(10*Y+.5)/10
8933 H$="*":IF Y(N)<YA THEN YA=Y(N)
8934 IF Y(N)>YB THEN YB=Y(N)
8935 YF=YB-YA:YF=INT(10*YF+.5)/10:YS$=" ":IF YF>4.0 THEN YS$="*"
8936 YF$="FLATNESS="+STR$(YF)+YS$
8937 IF Y(N)>Y1 AND Y(N)<Y2THEN H$=" "
8938 Y$(N)=STR$(Y(N)) +H$
8939 NEXT J
8940 PRINT#2,YF$:  PRINT#2,A5$
8945 GOSUB 6245
8950 FOR N=0 TO S2  STEP 5
8955 PRINT#2,J(N);Y$(N),Y$(N+1),Y$(N+2),Y$(N+3),Y$(N+4)
8960 NEXT N
8965 PRINT#2,"#################### END AMP GAIN @ -10DBM INPUT ##########"
8966 GOSUB 16000
8967 PRINT"CH":G.P :PRINT"TESTING COMPRESSION"
8970 RETURN
9500 REM*****************************
9501 FOR J=L TO H STEP S1:N=(J-L)/S1: REM  COMPRESSION ****************
9502 P=(23-Y(N))
```

```
9504 IF P=4 OR P>4 THEN GOTO 9510
9507 C4=(V2(N)-P(N))*(4-P)/2+P(N):      GOTO 9512
9510 C4=(V6(N)-P(N))*(P-4)/2+P(N)
9512 C4=INT(10*C4+.5)/10
9515 P$=STR$(C4):J$=STR$(J/1000)+"GZ"
9520 IECOUTS,J$:GOSUB6840
9525 IECOUTS,P$+"DM":GOSUB 4000
9532 C(N)=23-(K+VAL(Z$(N)))      :C(N)=INT(10*C(N)+.5)/10:C1$=" "
9534 J(N)=J:IF C(N)>1.2 THEN C1$="*"
9536 C$(N)=STR$(C(N))+C1$
9538 NEXT J
9540 PRINT#2,"COMPRESSION @+21DBM OUTPUT"
9545 GOSUB 6245
9550 FOR N=0 TO S2  STEP 5
9555 PRINT#2,J(N);C$(N),C$(N+1),C$(N+2),C$(N+3),C$(N+4)
9560 NEXT N
9565 PRINT#2,"################### END COMPRESSION ########################"
9570 PRINT"CH";G.P
9572 PRINT"READY FOR NEXT UUT"
9574 PRINT"*******************"
9575 RETURN
9700  FOR J=L TO H STEP S1:REM NORMALIZE @ ODBM ***************
9702 PRINT"CH":PRINT"-10DBM PWR BEING NORMALIZED=W1(N) FOR AMP MEA"
9705 J$=STR$(J/1000)+"GZ":REM SET FREQ
9710 IECOUTS,J$:N=(J-L)/S1:GOSUB 6840
9715 P$=STR$(P(N)-14)
9720 IECOUTS,P$+"DM"
9722 GOSUB 4000
9724 N=(J-L)/S1
9728 W1(N)=K
9730 NEXT J
9735 RETURN
10000 PRINT"CH":BEEP1500
10010 PRINT"INSERT 20 DB PAD PER FIG#2
10015 PRINT"*****************************"
10017 PRINT"HIT (SHIFT) WHEN READY"
10020 WAIT152,1
10025 HOLD 1000 :PRINT"CH"
10030 PRINT"20 DB PAD BEING CHECKED"
10040 RETURN
10100 PRINT"CH":BEEP1500
10105 PRINT"IS THE DATA ACCEPTABLE Y/N?"
10110 INPUT E2$:IF E2$="N" THEN PRINT"CH":PRINT"RESTART PROGRAM":HOLD10000:STOP
10112 PRINT#2," "
10113 PRINT#2,"-------------------------------------------------------------------------------"
10114 PRINT#2," "
10115 PRINT"CONNECT UUT PER FIG#3"
10120 BEEP1000
10121 PRINT"**********************"
10122 PRINT"OPERATOR INSTRUCTIONS"
10124 INPUT"UUT S/N";C$
```

```
10126 INPUT"COMMENTS";D$
10127 PRINT#2,"▼▼▼▼ S/N ";C$;" ▼▼▼▼":GOSUB 6250
10128 PRINT"HIT (SHIFT) AFTER UUT HAS BEEN CONNECTED"
10130 WAIT 152,1
10135 HOLD 1000:PRINT"␆"
10140 PRINT"UUT BEING TESTED"
10142 PRINT"GAIN @ 0DBM"
10150 RETURN
16000 REM AMPLIFIER GRAPHICS ###################################
16010 MIN=0:MAX=25 :GOSUB 6700
16020 OPEN 1,230:PRINT#1,CHR$(13):CLOSE1
16030 PRINT "␀   GAIN :  0 TO  25DB"
16040 G.M,J(1),Y(1)
16050 FOR I=2 TO 108
16060 G.L,J(I),Y(I)
16070 NEXT I
16080 G.C
16090 RETURN
17000 REM *********SUBROUTINE TO AUTO ZERO POWER METER**********************
17010 IECOUTS,"R0":HOLD3000:REM RF OFF
17015 IECTIME50
17020 IECOUT13,"Z1T"
17025 IECIN13,X$:X$=MID$(X$,5,5):X5=VAL(X$):PRINT"↑␍␊ZEROING STARTS␍␊"
17030 IF X5>2 THEN GOTO17020
17035 IECOUT13,"9D+I"
17040 IECIN13,X$:X$=LEFT$(X$,1):PRINT"␆": PRINT"␍␊↑STILL ZEROING␍␊"
17045 IF X$>="T"THEN GOTO17035
17050 PRINT:PRINT:PRINT"↑↑↑␍␊END OF ZEROING.  MAIN PROG.  UNDERGOING"
17055 HOLD5000
17060 IEC_REN
17065 IECREN
17070 IECOUTS,"R1":HOLD4000 :REM RF ON
17075 RETURN:REM####################
18100 PRINT "MEA/CALC V2(N)"  :REM**********************************
18105 FOR J=L TO H STEP S1:REM**********************************
18110 J$=STR$(J/1000)+"GZ":REM SET FREQ
18120 IECOUTS,J$:N=(J-L)/S1:GOSUB 6840
18130 P$=STR$(P(N)-2)
18140 IECOUTS,P$+"DM"
18150 GOSUB 4000
18160 E=2-K:C=P(N)-2+E:C=INT(10*C+.5)/10:REM ERR CALC
18165 P$=STR$(C):IECOUTS,P$+"DM"
18170 GOSUB 4000
18180 E=2-K:V2(N)=C+E:V2(N)=INT(10*V2(N)+.5)/10:REM 2ND CORR
18182 P$=STR$(V2(N)):IECOUTS,P$+"DM":GOSUB6840:      GOSUB4000:E=2-K
18185 IF E>.15 OR E<-.15 THEN PRINT#2,  "CAN NOT CORR V2 @ ";J;"MHZ.";E
18187 NEXT J
18190 PRINT#2,TI$:RETURN
18200 PRINT"MEA/CALC V6(N)"  :REM**********************************
18205 FOR J=L TO H STEP S1:REM**********************************
18210 J$=STR$(J/1000)+"GZ":REM SET FREQ
```

```
 18220 IECOUTS,J$:N=(J-L)/S1:GOSUB 6840
 18230 P$=STR$(P(N)+2)
 18240 IECOUTS,P$+"DM"
 18250 GOSUB 4000
 18260 E=6-K:C=P(N)+2+E:C=INT(10*C+.5)/10:REM ERR CALC
 18265 P$=STR$(C):IECOUTS,P$+"DM"
 18270 GOSUB 4000
 18280 E=6-K:V6(N)=C+E:V6(N)=INT(10*V6(N)+.5)/10:REM 2ND CORR
 18282 P$=STR$(V6(N)):IECOUTS,P$+"DM":GOSUB 6840  :GOSUB4000:E=6-K
 18285 IF E>.15 OR E<-.15 THEN PRINT#2,  "CAN NOT CORR V6 @ ";J;"MHZ.";E
 18287 NEXT J
 18290 PRINT#2,TI$: RETURN
 18400 PRINT#2,"ROUTINE FOR CHECKING AUTO CAL & INTERPOLATION"
 18405 FOR P=2 TO 6 STEP 1:PRINT#2,"J","K","   ","V2(N)","C4"
 18410 FOR J=L TO H STEP S1 :                N=(J-L)/S1
 18420 IF P=4 OR P>4 THEN GOTO 18430
 18425 C4=(V2(N)-P(N))*(4-P)/2+P(N):      GOTO18435
 18430 C4=(V6(N)-P(N))*(P-4)/2+P(N)
 18435 C4=INT(10*C4+.5)/10
 18440 P$=STR$(C4):J$=STR$(J/1000)+"GZ"
 18450 IECOUTS,J$:GOSUB6840
 18455 IECOUTS,P$+"DM"
 18460 GOSUB4000
 18470 PRINT#2,J,K,V2(N),C4
 18480 NEXT J
 18490 NEXT P
 18495 RETURN
READY.
```

2-49. AM MODULATION

2-50. Amplitude modulation of a carrier by a low frequency signal will increase the peak signal to the sum of both peak amplitudes (See Fig. 2-6). The mathematical expression is:

$$Emax = E_c + E_m$$

The degree of modulation is given by:

$$m = \frac{Emax - E_c}{E_c}$$

or $$m = \frac{Emax - Emin}{Emax + Emin}$$

In the AM mode, the generator is not able to modulate without distortion at RF levels that need to go beyond the highest unmodulated carrier levels. For example, Emax $-$ E_c = 5, 5dB. The highest level able to be amplitude modulated is approximately 6 dB below the maximum cw level. To measure accurate modulation index with a spectrum analyzer, refer to Fig. 3-6.

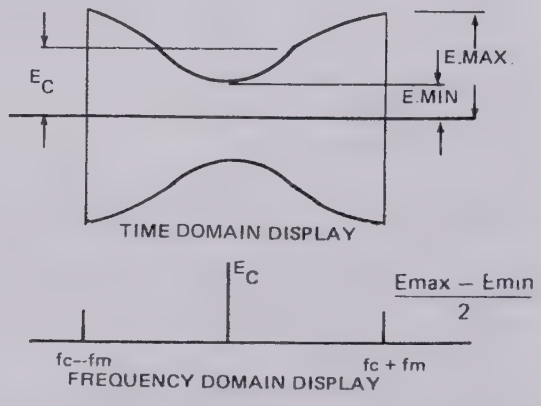


Figure 2-6. Amplitude Modulation

2-51. FM MODULATION

2-52. The generator has an internal oscillator to frequency modulate the RF output. The rate of modulation and the excursion of the signal from the carrier is easily set. The modulation index is given by:

$$m = \frac{\Delta F \text{ peak}}{fm}$$

Where ΔF is the deviation from the carrier. Figure 2-7 shows a typical display of FM in the frequency domain.

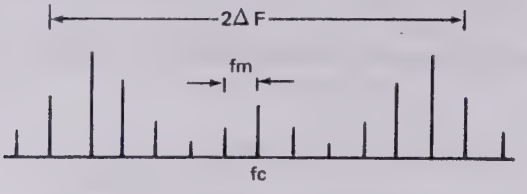


Figure 2-7. Frequency Domain Display

For a constant frequency deviation, the change of frequency rate will produce a change of modulation index. Each band will increase or decrease amplitude as shown in figure 2-8.

The following modulation indices will null the carrier.

ORDER OF CARRIER	INDEX
1	2.4
2	5.52
3	8.65
4	11.79
5	14.93
6	18.07
n(n>6)	18.07 + PI(n−6)

The sum of the square of all the components will remain constant and equal to the cw signal.

For a modulation index of 5:

J_0 = 0.19	0.0361		0.0361
J_1 = 0.33	0.1089		0.2178
J_2 = 0.04	0.0016		0.0012
J_3 = 0.35	0.1225		0.2450
J_4 = 0.39	0.1521	2 Side	0.3042
J_5 = 0.26	0.6076	Bands	0.1352
J_6 = 0.13	0.0169		0.0338
J_7 = 0.06	0.0036		0.0072
J_8 = 0.02	0.0004		0.0008
			0.9833

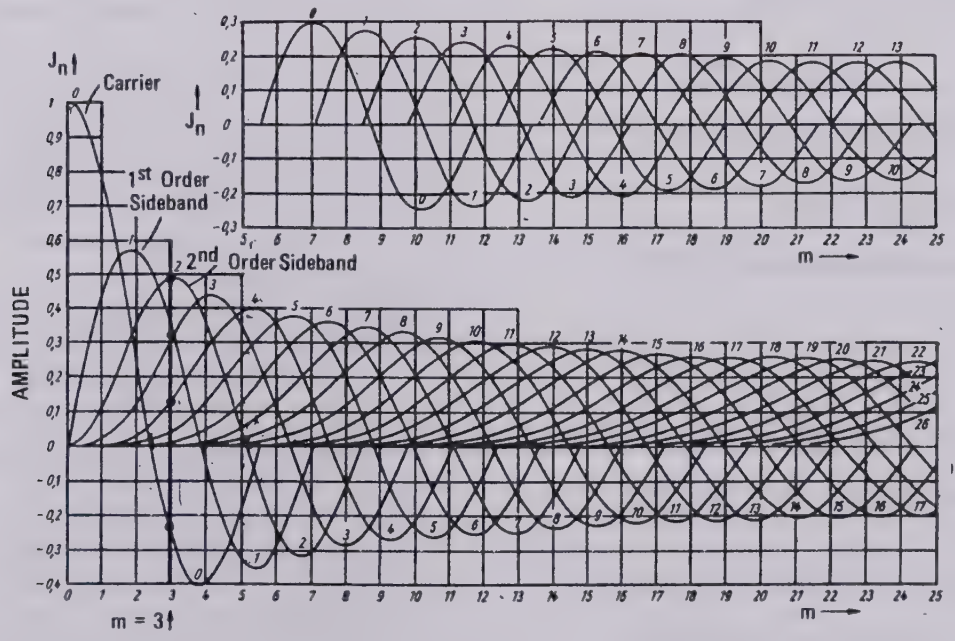


Figure 2-8. Carrier and Sideband Amplitudes for Angle-Modulated Signals.

Figure 2-9 shows an FM signal of 10 GHz modulated by a 100 kHz rate signal and a deviation of 1 MHz.

Figure 2-9. FM Signal of 10 GHz Modulated by a 100 kHz Rate Signal and a Deviation of 1 MHz.

In the synthesized mode, the highest modulation for the generator is m = 10.

2-53. PULSE MODULATION

2-54. The excellent pulse generator built into the Model 309 allows precise measurements of radar receivers. Figure 2-10 shows the pulse spectrum.

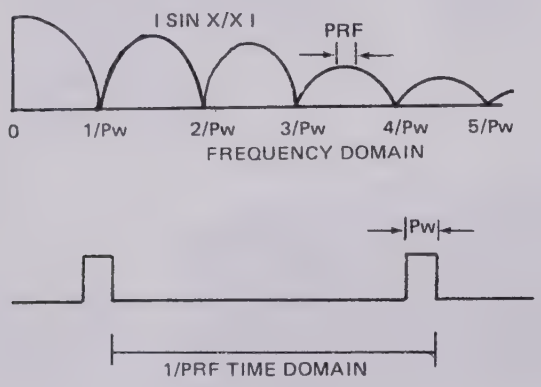


Figure 2-10. Pulse Spectrum

Figure 2-11 shows the low AM leakage and negligible phase distortion of the 10 GHz RF signal modulated with a narrow pulse.

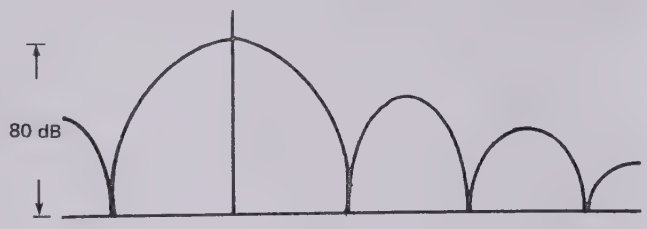


Figure 2-11. Low AM Leakage and Phase Distortion of a 10 GHz RF Signal

SECTION III

MINIMUM PERFORMANCE TESTS

3-1. GENERAL

3-2. The minimum performance tests outlined in this section will determine whether the instrument is operating within the specification limits listed in Table 1-1. The following conditions should be applied before performing any test.

a. Input power voltage should be 115 volts or 220 volts ±10%.

b. Ambient temperature must be 28°C ±5°C.

c. Instrument must be warmed up for a period of one hour or more.

3-3. SYNTHESIZED SECTION

3-4. In order to verify the locking capability of the instrument proceed as follows:

a. Connect equipment as shown in Figure 3-1.

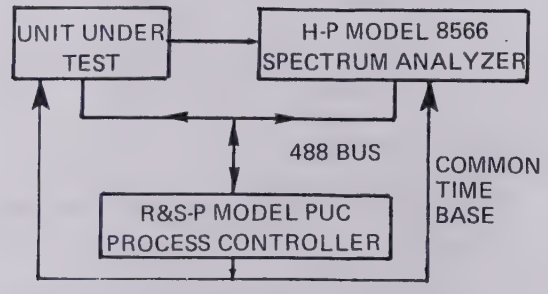


Figure 3-1. Locking Capability Test Setup

b. Use the following program.

```
20 S=29:L:D=5.4:OPEN2,230:A=18:
   TI$="000000"
80 IECOUTA,"IPKS=S2SP2MZRL10DM":
   IECOUTS,"10DMCMR1"
85 F$=STR$(D*RND(.3)+L)+"GZ:
   IECOUTA,"SP.SMZCF"+F$
87 IECOUTS,F$IECOUTA,"TSE1MA":
   IECINA,R$
90 IFVAL(R$) (2THENPRINT#2,TI$,
   F$,R$*STOP
95 GOTO85
READY
```

Note: If unit fails, refer to Section IV.

3-5. SIGNAL PURITY

3-6. To perform the signal purity test, proceed as follows:

a. Connect the equipment as shown in Figure 3-2.

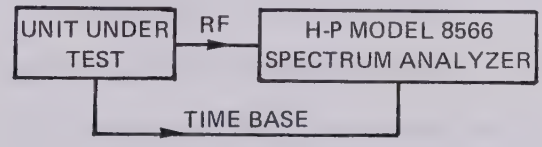


Figure 3-2. Signal Purity Test Setup.

b. Set both instruments to 18.0 GHz.

c. Set Spectrum Analyzer span to 1 MHz.

d. Look for spurious signal at 400 kHz off the carrier.

e. Set Spectrum Analyzer span to 200 kHz.

f. Set Spectrum Analyzer to phase noise measurement.

g. Look for single sideband noise at 100 kHz.

h. Set Spectrum Analyzer span to 50 kHz.

i. Look for single sideband noise at 10 kHz.

j. Set Spectrum Analyzer span to 1.2 kHz.

k. Look for spurious signals at 60, 120, 240, and 360 Hz from carrier.

l. Set both instruments to 12.31137 GHz.

m. Look for spurious level at 15 kHz.

3-7. INCIDENTAL FM

3-8. This test measures the FM of the output and frequency error when in the unlocked mode. To perform this test proceed as follows:

a. Connect equipment as shown in Figure 3-3.

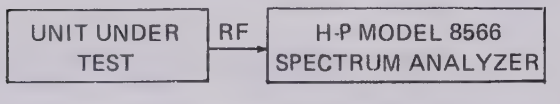


Figure 3-3. Incidental FM Test Setup.

b. Set both instruments to their middle ranges.

c. Set Spectrum Analyzer span to 200 MHz.

d. Set Model 309 to 0 deviation sweep.

e. Center the display on the screen.

f. Record the ΔF from the Spectrum Analyzer.

g. Set Spectrum Analyzer span to 200 kHz.

h. Record the incidental FM (peak-to-peak) from the Spectrum Analyzer.

3-9. R.F. OUTPUT

3-10. This test will verify the condition of the attenuation system. To perform this test proceed as follows:

a. Connect the equipment as shown in Figure 3-4.

b. Set the Model 309 to its middle frequency.

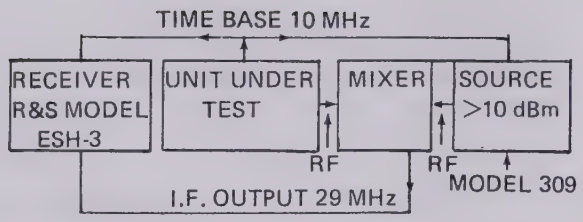


Figure 3-4. R.F. Output Test Setup

c. Set Source to same frequency + 29 MHz.

d. Set Receiver to 29 MHz and resolution to 200 Hz.

e. Set Model 309 LEVEL output to 0 dBm.

f. Read Receiver level.

g. Step down attenuator in 10 dB steps to −110 dBm.

h. Record readings.

i. Connect Model 309 to Power Meter.

j. Record readings for +10 and 0.

k. Set Model 309 to +10 dBm.

l. Start with the lowest frequency and proceed to the highest frequency of the Model 309 in 100 MHz steps.

m. Record the minimum and maximum level at at each step.

3-11. MODULATION

a. **AM.** This test measures depth of modulation and distortion.

(1). Connect equipment as shown in Figure 3-5.

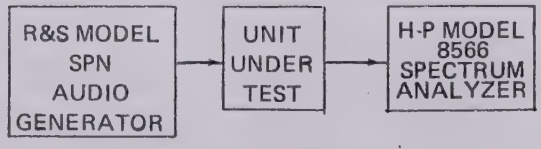


Figure 3-5. AM Depth of Modulation and Distortion Test Setup

(2) **Depth of Modulation**

a) Set Audio Generator to 10 kHz signal.

b) Inject a precise 2V peak-to-peak signal (loaded) into the AM IN connector of the Model 309.

d) Set the Model 309 and Spectrum Analyzer to their middle frequencies.

e) Set the span of the Spectrum Analyzer to 25 kHz.

f) Set the Model 309 to %AM 10.

g) Measure the change in level between carrier and modulation.

h) Set the Model 309 to %AM 20, 30, 40, 50, 60, and 70.

i) Record the readings in dB.

j) Use Figure 3-6. to find the actual depth of modulation.

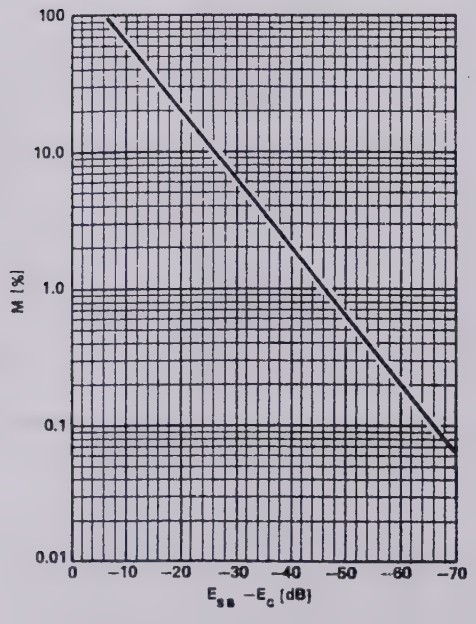


Figure 3-6. Modulation Percentage vs. Sideband Level.

(3) **Distortion**

a) Set Audio Generator to 10 kHz signal.

b) Inject a precise 2V peak-to-peak signal (loaded) into the AM connector of the Model 309.

c) Set the Model 309 and Spectrum Analyzer to their lowest frequencies.

d) Set Model 309 to %AM 70.

e) Look for second, third, and up to nine harmonics.

f) Calculate distortion by using Table 3-1 for each harmonic of the modulation signal. Record the level and locate that level in column A. Record the corresponding power ratio. Add all power ratios and locate the percentage distortion in column B that corresponds to this total power.

b. **FM (Lock Mode or Unlock Mode).** This test measures peak-to-peak deviation and rate.

(1) **Rate**

For the rate test it is necessary to connect the FM-SWP OUT connector to an audio counter. The rate error is:

$$\text{Rerror} = \frac{\text{Rdisplay} - \text{Rcounter}}{\text{Rcounter}} \%$$

(2) **Deviation**

Deviation is measured in the Spectrum Analyzer using the carrier null technique. Connect the Model 309 to the Spectrum Analyzer. Use Table 3-2 for commonly used values of deviation. For any other combination divide the deviation by the modulation index of 2.4. Set the modulation rate at that frequency. Change the rate frequency slightly until the first order is null. Connect an Audio Counter to the FM OUT connector of Model 309. Read the FM rate, multiply by the modulation index (2.4) and the result will be the exact deviation.

TABLE 3-1. AM DISTORTION

A Ratio To Fundamental (dB)	Power Ratio	B Distortion (%)	A Ratio To Fundamental (dB)	Power Ratio	B Distortion (%)
0	1.000000000	100.000	−31	0.000794328	2.818
−1	0.794328235	89.125	−32	0.000630957	2.512
−2	0.630957344	79.433	−33	0.000501187	2.239
−3	0.501187234	70.795	−34	0.000398107	1.995
−4	0.398107171	63.096	−35	0.000316228	1.778
−5	0.316227766	56.234	−36	0.000251189	1.585
−6	0.251188643	50.119	−37	0.000199526	1.413
−7	0.199526231	44.668	−38	0.000158489	1.259
−8	0.158489219	39.811	−39	0.000125893	1.122
−9	0.125892541	35.481	−40	0.000100000	1.000
−10	0.100000000	31.623	−41	0.000079433	0.891
−11	0.079432823	28.184	−42	0.000063096	0.794
−12	0.063095734	25.119	−43	0.000050119	0.708
−13	0.050118723	22.387	−44	0.000039811	0.631
−14	0.039810717	19.953	−45	0.000031623	0.562
−15	0.031622777	17.783	−46	0.000025119	0.501
−16	0.025118864	15.849	−47	0.000019953	0.447
−17	0.019952623	14.125	−48	0.000015849	0.398
−18	0.015848932	12.589	−49	0.000012589	0.355
−19	0.012589254	11.220	−50	0.000010000	0.316
−20	0.010000000	10.000	−51	0.000007943	0.282
−21	0.007943282	8.913	−52	0.000006310	0.251
−22	0.006309573	7.943	−53	0.000005012	0.224
−23	0.005011872	7.079	−54	0.000003981	0.200
−24	0.003981072	6.310	−55	0.000003162	0.178
−25	0.003162278	5.623	−56	0.000002512	0.158
−26	0.002511886	5.012	−57	0.000001995	0.141
−27	0.001995262	4.467	−58	0.000001585	0.126
−28	0.001584893	3.981	−59	0.000001259	0.112
−29	0.001258925	3.548	−60	0.000001000	0.100
−30	0.001000000	3.162			

TABLE 3-2. LIST OF MODULATION FREQUENCIES TO BE USED TO SET UP CERTAIN CONVENIENT DEVIATIONS

Order Of Carrier Zero	Modulation Index	Commonly Used Values of FM Peak Deviation										
		7.5 kHz	10 kHz	15 kHz	25 kHz	30 kHz	50 kHz	75 kHz	100 kHz	150 kHz	250 kHz	300 kHz
		*	*	*	*	*	*	*	*	*	*	*
1	2.40	3.12	4.16	6.25	10.42	12.50	20.83	31.25	41.67	62.50	104.17	125.00
2	5.52	1.36	1.81	2.72	4.53	5.43	9.06	13.59	18.12	27.17	45.29	54.35
3	8.65	0.87	1.16	1.73	2.89	3.47	5.78	8.67	11.56	17.34	28.90	34.68
4	11.79	0.66	0.85	1.27	2.12	2.54	4.24	6.36	8.48	12.72	21.20	25.45
5	14.93	0.50	0.67	1.00	1.67	2.01	3.35	5.02	6.70	10.05	16.74	20.09
6	18.07	0.42	0.55	0.83	1.88	1.66	2.77	4.15	5.53	8.30	13.84	16.60

*Modulation Signal Frequency Rate

Any order of carrier zero can be used if the appropriate modulation index is used. Ex., for an FM rate of 20 kHz, increase deviation until the third order is null. The deviation will be exactly 20 kHz x 8.65 = 173 kHz. Check this number against the displayed digit deviation. The error will be:

$$DEV_{error} = \frac{DEV - 173}{173} \times 100\%$$

(3) **PULSE.** The pulse test verifies the functioning of the internal pulse generator and modulation of the RF signal.

a) Connect the equipment as shown in Figure 3-7.

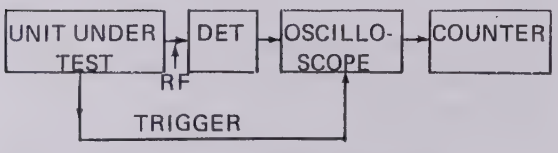


Figure 3-7. Pulse Test Setup

b) Set the Model 309 to 10 kHz RT, 10 μWD, and 20 μsDELAY.

c) Set the oscilloscope for a steady calibrated display.

d) Read the length of the pulse and delay on on the oscilloscope.

e) Read the frequency in the counter.

f) Set the Model 309 to 1 μsDELAY, 100 ns pulse width and 200 kHz rate.

g) Set the oscilloscope for a steady and calibrated display.

h) Read the length of the pulse, delay, and rise and fall time on the oscilloscope.

i) Read the frequency in the counter.

SECTION IV

THEORY OF OPERATION

4-1. INTRODUCTION

4-2. This section describes the theory of operation for Synthesized Microwave Signal Generator Model 309. The section is divided into two parts. The first is a block diagram analysis and the second part is a detailed circuit description of the components of the signal generator.

4-3. BLOCK DIAGRAM ANALYSIS (See Figure 4-1)

4-4. The signal generator is integrated by five lock loops, and a "chain" of microwave elements necessary to sample, modulate and attenuate the signal. A switching power supply and modulator circuitries drive the various modules. The following is a list of modules/PC boards that integrate the signal generator:

Module/PC Board	Name
A1	Reference Frequencies (1st Loop)
A2	Loop No. 2 Divider (2nd Loop)
A3	Loop No. 2 V.C.O. (2nd Loop)
A4	Loop No. 3A (3rd Loop)
A5	Loop No. 3B (4th Loop)
A6	Pulse Modulator
A7	AM/FM Modulator
A8	Power Supply Module
A9A1	Display Board
A9A2	Microprocessor Board
A11	R.F. Head

4-6. **Reference Frequencies.** The stability and coherence of the output signal is determined by the A1 Reference module. These frequencies are multiples or submultiples of a standard frequency (namely 10 MHz). The output frequencies of the A1 module are 25 kHz, 1 MHz, and 400 MHz.

4-7. **Phase Lock Loop No. 2.** The low frequency loop determines the high resolution of the synthesizer. The reference frequency for this loop is 25 kHz. The output frequencies vary between 8 MHz to 33 MHz in 1 kHz steps. The module consists of two P.C. Boards (A2 and A3). A2 is a programmable fractional divider, with a fixed frequency output of 25 kHz and a variable frequency input from 40 MHz to 165 MHz.

4-8. **Phase Lock Loops No. 3A and 3B.** The output of these boards assembled in two well defined P.C. Boards A4 (Loop No. 3A) and A5 (Loop No. 3B) determines the larger steps in the frequency resolution and cover frequencies from 374 to 395 MHz in 1 MHz steps. The Loop No. 3A board accepts a reference frequency of 1 MHz and converts up to an output of 36 to 52 MHz in 1 MHz steps. This output is used as a reference for the Loop No. 3B board.

4-9. **Phase Lock Loop No. 4.** This is the main loop since the microwave source is part of it. The output of loop No. 3B is amplified and drives a harmonic generator, producing frequencies near the desirable output frequency. The yig oscillator is pretuned to a frequency close to the programmable output frequency. Loop No.4 will pull the yig to the exact frequency, phase locking the desirable harmonic of loop No. 3 and the output of loop No.2. This module has three P.C. boards holding the phase lock loop circuitry and other additional circuitries for attenuation and modulation purposes. The microwave "chain" needed to control the output level and modulate the signal are part of this module.

4-10. **Controller and Display A9.** This assembly is attached to the front panel and consists of two P.C. boards. The Display Board A9A1 is attached directly to the front panel. The second board, Microprocessor Board A9A2 has the microprocessor, memories, interface circuitries to handle data in and out of the controller.

4-11. **Power Supply A8.** The power supply is an enclosed assembly that provides power to the modules. It is

of the switching power supply type. The input voltages are switchable for 110V/220V and are independent of input frequency inside the range of from 50 Hz to 400 Hz. The output voltages are +5V, +10.5V, +15V, −15V.

4-12. **Modulation.** All signals necessary to modulate the R.F. waveform are contained in boards A6 and A7. The pulse generator is located in the A6 board and has circuitries to control the delay and pulse width. AM/FM board A7, generates a signal from 0.01 Hz to 200 kHz and attenuates and switches different signals to perform AM and FM modulation, in addition to driving the large step R.F. attenuator.

4-13. DETAILED CIRCUIT DESCRIPTION

4-14. The following paragraphs describe in detail the operation of each module starting with the frequency synthesizer minor loops, followed by the modulation modules, power supply, control and display modules, and R.F. Head.

4-15. **Loop No. 1 Operation A.** The main oscillator from which all other reference frequencies derive, is a 100 MHz crystal oscillator, with very low sideband noise. The oscillator transistor Q6 is frequency locked by a 10 MHz time base temperature stabilized oscillator. The error voltage shown at the output of U5 may vary from 5 to 11 volts. If an external 10 MHz signal is connected, U3-2 goes high, switching U3 and turns off the power to the internal time base. The 10 MHz signal at the output U6 is divided by integrated circuit U10 to 1 MHz, to be used as a reference for 3A. The signal is further divided by U7, U8, and U9 up to 25 kHz to be used as a reference for loop No. 2. The 100 MHz signal from the main oscillator is amplified by Q10 and multiplied by Q12 and Q13 to 400 MHz to be used by the loop No. 3B converter.

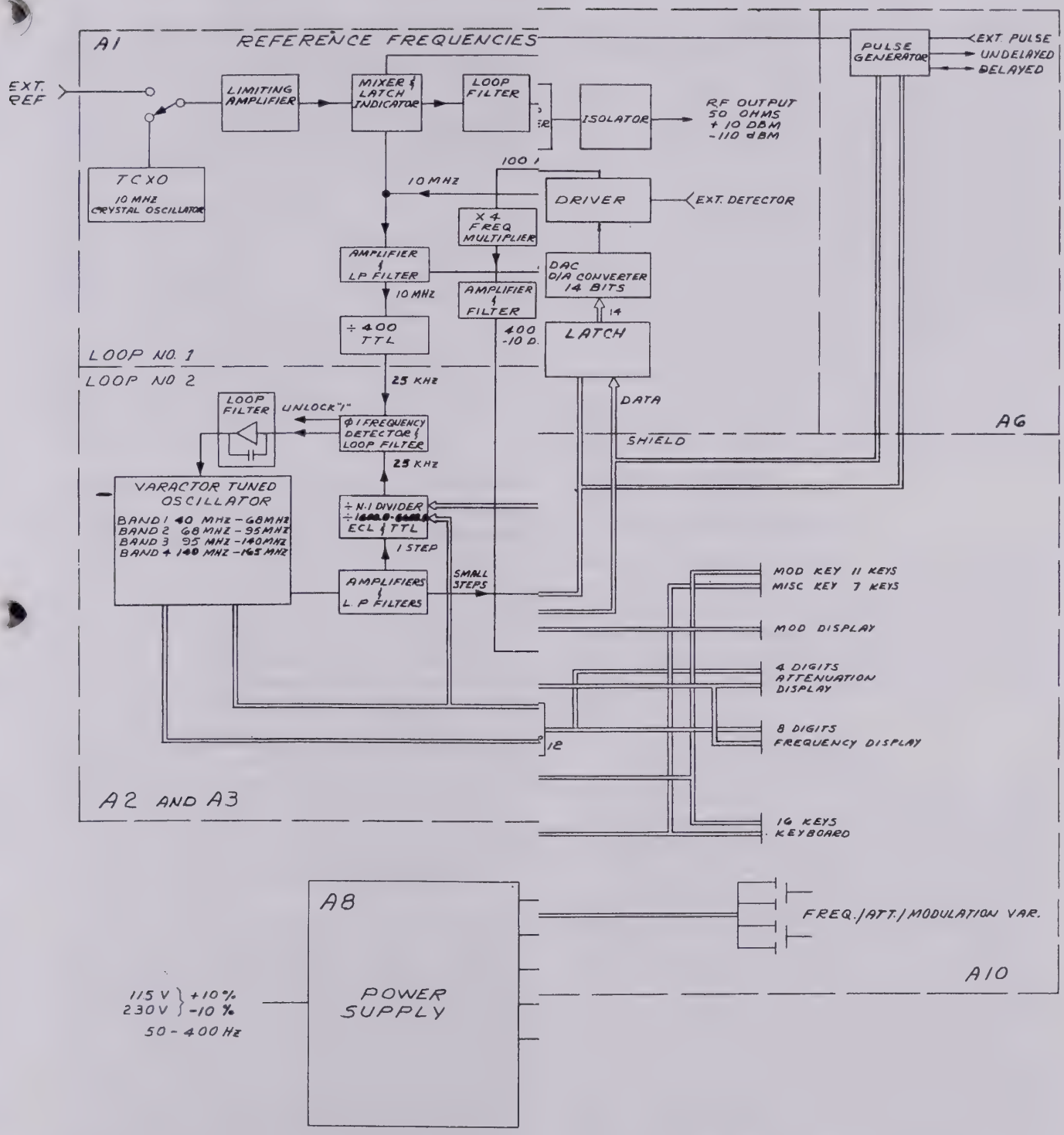
4-16. **Loop No. 2 Operation.** This loop provides small step frequency resolution and is assembled in two boards. Transistor A3Q4 is the active element of the VCO. The frequency band is controlled by L1, L2, L3, or L4, depending upon which coil is switched "On." The four band frequencies are controlled by varactors CR8 and CR9. The output is divided into two branches, one to drive the A2 board divider and the other, after being divided by 5, is fed to the R.F. head. The return of the divider is fed to the flip-flop discriminator U5 − U18, together with the reference frequency of the oscillator and maintains the frequency lock to the reference. The gate U1C provides an indication of the lock status. The Light Emitting Diode DS1 will light when the circuit is locked.

4-17. **Divider A2.** The input signal is divided by U1 by 10 or 11 depending upon U19 flip-flop state. The output of U1 is divided by U2, U3, and U4. The outputs are combined in U18. The output of the divider module (namely 25 kHz) is used to reset U2, U3, and U4, to clock the fractional divider U10 and reset unit divider U7. The fractional division is accomplished by alternating the output frequency in such a way that the average rate is a fractional amount. Integrated circuits U9, U10, and U11 determine the fraction divider and U7, U8, U9, and U19 determine the units.

4-18. **Loop No.3A.** Loop No. 3A provides the large step frequency resolution in conjunction with loop No. 3B. The 3A oscillator covers frequencies from 36 to 52 MHz in 1 MHz steps. Transistor Q2 is the active element of the VCO that oscillates between base and emitter. The output of Q2 is buffered and limited, and a portion of the signal goes to loop No. 3B and the other portion goes to dividers U5, U6, U7, and U8. Transistors Q6 and Q7 are level shifters to convert ECL to TTL. Integrated circuits U3 and U4 are frequency discriminators, phase detector whose output is fed to a pump discharge Q3, Q4, and Q5 to provide tuning voltage to maintain the oscillator lock.

4-19. **Loop No. 3B.** Loop No. 3B is a VCO that generates a signal between 374 and 395 MHz in 1 MHz steps. The low noise oscillator components are Q5 and a semi-rigid transmission line whose frequency is controlled by CR5. The output has two branches: one goes to the R.F. head and the other drives the mixer that converts the frequency down from a 400 MHz reference to a low frequency IF of 5 to 26 MHz. This output is filtered, amplified, and divided by 2 to drive a flip-flop phase detector frequency discriminator. The output is amplified and filtered by U10. The output voltage controls the frequency of the oscillator. The signal coming from loop No. 3A is amplified and divided. The divider output drives a 2 to 10 programmable counter U6. The output goes to phase detector U15. Integrated circuit U8 is a comparator detector to monitor tuning voltage and reset the oscillator through Q5 in case of out of limits tuning voltages.

4-20. **R.F. Head.** This module contains the microwave source, microwave components to modulate and attenuate the R.F. signal, attenuator and yig drivers, interface circuitry from analog to digital levels and necessary circuitry to lock the yig source to signals coming from loops



Synthesized Microwave Signal Generator Model 309, Block Diagram

No. 2 and 3B. The R.F. Head is computer calibrated and is used as a sealed unit. The level calibration of the R.F. Head is contained in 2 EPROMS plugged into sockets U6 and U7 of Microprcessor Board A9A2. The R.F. Head contains 10 variable resistors used for tuning in case of required maintenance. The R.F. Head adjustments are as follows:

R4 Phase Detector Alignment
R15 Search Equalizer
R18 Lock Adjustment
R46 10 GHz Adjustment
R48 17 GHz Adjustment
R77 Level Attenuation Adjustment
R83 2 kHz, 7.07 mV Adjustment
R84 12 kHz, 4.25 mV Adjustment
R85 200 kHz, 425 mV Adjustment
R86 200 kHz, 707 mV Adjustment

4-21. **Pulse Board.** This module receives a trigger signal, provides a delay between input and starting of the pulse, generates the pulse to drive a pin switch. The input signal can either come from the signal generator from AM/FM Modulator Board through P1 or an external signal through P4. The integrated circuit selects the source and drives ½ U11 flip-flop. The D/A converter U3 output sets the time delay between the input signal and the starting of the pulse. The delay circuit is integrated by Q1,Q2,Q3,Q4,Q5, Q11, Q12, and Q20, while U11 switches capacitors for the five ranges. The output pulse from the delay circuit clocks the flip-flop ½U12 on pin 3, then pin 5 goes high and releases Q19. Pulse shaping and level shifting are controlled by Q6, Q7, Q8, Q9, Q13, Q17, and Q19, while the D/A converter U8 controls the pulse width. The output pulse is fed to pin 2 of switch U13. Transistors Q13, Q15, and Q16 drive the pulse pin with positive and negative levels.

4-22. **AM/FM Board A7.** This module contains the function generator used for FM and pulse modulation, a calibrated signal attenuator for FM deviation and large step attenuator driver and AM calibration. Integrated circuit U13 is a function generator with 4 ranges that covers frequencies from 0.02 Hz to 200 kHz. The frequency is controlled by D/A U8. The output signal from U13 is applied to U20 through a different path. D/A attenuates the signal, giving the FM resolution. The AM input signal at P4 is attenuated in U6, giving the 1% step of depth of modulation. Active element Q7, Q9, and Q18 will introduce a nonlinear amplification, to compensate for the nonlinearity of the pin attenuator. Switch U14 controls the 5 attenuation steps in the large step attenuation pin.

4-23. **Power Supply.** The power supply is a switching type and contains two boards. The powerline voltage input to A8J1 is fused and filtered and applied to transformer T1 and to bridge rectifier CR2. The dc voltage is applied to the filter (C5,C6) across the fets in series. The fet switches "ON" and "OFF" at different times producing a square wave rate of 200 kHz and approximately 350 volts, driving transformer T4. Multiple secondary outputs give the different voltages supplied for the unit. A sampling of the +5V supply is applied to U3, that produces a square wave of 250 kHz and variable duty cycle proportional to the 5V input. This push-pull square wave drives U2 and two fets. Resistors R19, R20, R21, and R22 form a bridge to shut down the power supply in case of overheating. Transistors Q3 and Q4 are used for power supply protection. Resistors R13 and R26 are used for adjustments of +5v and +10.5v.

4-24. MICROPROCESSOR SYSTEM

4-25. The following paragraphs provide information relating to the microprocessor system; the microprocessor, memory map, input devices, and I/O interface organization, as well as a completee view of the synthesizer looking from the microprocessor side. The microsystem consists of two printed circuit board assemblies, their assembly designations are:

A9A1	Display/Keyboard
A9A2	Microprocessor Board

4-26. **Microprocessor.** The Intel Microprocessor 8085 is used to control the entire synthesizer including the front panel display/keyboard, RF attenuator, phase lock loops, YIG oscillator, IEEE 488 Std. GP1B interface and various modulation functions. The 8085 microprocessor is an 8-bit microprocessor with multiplexed data and address lines. It can access up to 64 kilo bytes of memory and 256 I/O devices, The 8085 has 4 vectored and one general purpose interrupt inputs, the general purpose input is not used here. These interrupt inputs are the vital link between user input devices such as keyboard, spinwheel, and GPIB to interrupt the microprocessor. Each input has its unique vectored instruction and level of priority to handle the necessary task in a predetermined order. The 8085 is clocked at 5 MHz, that is equivalent to 1.2 million instructions. Most of the calculations take less than a few hundred microseconds and the microprocessor is essentially in an idle state most of the time.

4-27. **Memory Map.** There are 16 address lines to select one location at a time. A total of 64,000 locations can be accessed, whether there are ROM (read-only-memory), RAM (random-access-memory)) or I/O port, as long as they do not overlap and the proper address code is used. The complete memory map, including I/O interfaces, are listed in Table 4-1. The 32k bytes of the system program are stored in 2 EPROMS (U6 and U7 of A9A2). The 2k bytes of the system RAM are in A9A1U16, which can retain data for at least 72 hours by using a CMOS static RAM and a very large (0.5 μF capacitor). The keyboard controller and display controller are both located on Display/Keyboard A9A1. Two 8279s are used for controlling the keyboard, spinwheel LED, and 7-segment numerical displays. Each contoller uses only 2 out of 2k addresses for simplification of the address coder. (Refer to Intel data sheet for internal programming details.) An 1891 is used for IEEE 488 Bus interface. All the bus timing, handshaking, and protocols are handled by 8291 internally. Remote control of the synthesizer is accomplished through this peripheral device. The IEEE Bus interface address of the synthesizer is programmable by a DIP switch located at the top of A9A1. Refer to Section II for data relating to the usage of this switch. I/O data-in is used for reading data from an Analog-to-Digital converter, which has 8 channels of analog voltage input; such as internal reference voltage, internal power detector, and various power supplies. Phase-lock-loop status are phase error lines for each phase-lock-loop locking status, a high of the line indicates either that the loop is not connected or the loop is not locked. I/O data-out is used for sending data to various functions. It can have up to 32 functions maximum. A complete I/O function map is discussed in paragraph 4-28. The calibration look-up table contains data for output level calibration and they are unique for each unit.

TABLE 4-1. SYNTHESIZER MEMORY MAP

ADDRESSES DECIMAL	ADDRESSES HEX	SIZE BYTES	FUNCTION NAME
0-32767	0-7FFF	32k	System Program
32768-34815	8000-87FF	2k	System RAM
34816-36863	8800-88FF	2k	Keyboard Controller
36864-38911	9000-97FF	2k	Display Controller
38912-40959	9800-9FFF	2k	GPIB Controller
40960-43007	A000-A7FF	2k	GPIB Address DIP Switch
43008-45055	A800-AFFF	2k	I/O Bus Data-In
45056-47103	B000-B7FF	2k	Phase-Lock-Loops Status
47104-49151	B800-BFFF	2k	I/O Bus Data-Out
49152-65535	C000-FFFF	16k	Calibration Look-Up Table

4-28. **I/O Function Map.** The synthesizer contains several phase-lock-loops, and various controllable functions for internal modulation circuitry, such as; modulation rate generator, FM deviation generator, AM depth generator, pulse width and delay generator, sweep rate and deviation generator. All these functions are controlled by the microprocessor through a common data and address bus called the I/O bus. Each printed circuit board may contain several functions (some of the boards do not have controllable functions) and its' own address decoder, which are enabled by either OPE1 or OPE2 output enable line, depend on their address line. Table 4-2 is an I/O function map for the unit. It represents a complete view of the controllable hardware of the synthesizer.

TABLE 4-2. I/O FUNCTION MAP

ADDRESS	OPE*	OFFSET	ASSY NO.	FUNCTION
B810	1	0		Not Used
B811	1	1		PLL No. 2, least significant two digits
B812	1	2		PLL No. 2, more significant two digits
B813	1	3		PLL No. 2, most significant two digits
B814	1	4		Not Used
B815	1	5		Read data or start conversion of A/D
B816	1	6		PLL No. 3A
B817	1	7		PLL NO. 3B
B818	1	8		YIG oscillator tuning, DAC lower 8 bits
B819	1	9		YIG oscillator tuning, DAC upper 4 bits
B81A	1	10		Vernier step attenuator, DAC control
B18B	1	11		Vernier step attenuator, DAC data
B81C	1	12		A/D channel select
B81D	1	13		Not Used
B81E	1	14		Not Used
B81F	1	15		PLL No. 2 band select
B820	2	0		FM deviation, DAC upper 4 bits
B821	2	1		FM deviation, DAC lower 8 bits
B822	2	2		Rate generator, band select
B823	2	3		Rate generator, DAC upper 4 bits
B824	2	4		Rate generator, DAC lower 8 bits
B825	2	5		FM int/ext and attenuator (LSA) control
B826	2	6		AM deviation, upper 8 bits
B827	2	7		AM deviation, lower 4 bits
B828	2	8		Pulse delay and width range select
B829	2	9		Pulse delay, DAC
B82A	2	10		Pulse width, DAC
B82B	2	11		Pulse int/ext trigger control
B82C	2	12		Pulse delay, CSMSB
B82D	2	13		Pulse delay, CSLSB & LDAC
B82E	2	14		Pulse width, CSMSB
B82F	2	15		Pulse width, CSLSB & LDAC

*OPE = Output Enable

SECTION V

MAINTENANCE

5-1. INTRODUCTION

5-2. This section contains the maintenance procedures required to check, troubleshoot and align the instrument. Minimum performance standards are outlined in Section III and should be used to determine if maintenance is required.

5-3. ERROR CODES

5-4. The signal generator has a built in series of error codes that may appear during count-down or each time that data are input into the instrument. During count-down, the microprocessor checks power supply limits, loops lock failure, R.F. source and amplifier level limits, and A/D circuit failures. Each time that frequency data are input, there are error codes to indicate failure of loop locking. Table 5-1 lists the error codes that will indicate circuit and possible module failure.

TABLE 5-1. ERROR CODES

ERROR #	CONDITION	TOLERANCES	POSSIBLE MODULE FAILURE
1	+5 volts out of specification	±0.25 volt	A8A1/A8A2
2	+10.5 volts out of specification	±0.5 volt	A8A2
3	+15 volts out of specification	±0.75 volt	A8A2
4	−15 volts out of specification	±0.75 volt	A8A2
5	Loop No. 1 unlocked		A1
6	Loop No. 2 unlocked		A2/A3
7	Loop No. 3A unlocked		A4
8	Loop No. 3B unlocked		A5
9	Loop No. 4 unlocked		A11
10	Yig and Amplifier out of specification	20 dBm ±4dB	Yig or Amplifier
14	A/D circuit failure		A11
25	Loop No. 1 unlocked		A1
26	Loop No. 2 unlocked over full range		A2/A3
27	Loop No. 3A unlocked over full range		A4
28	Loop No. 3B unlocked over full range		A5
29	Loop No. 4 unlocked over full range		A11

NOTE: Error messages code can be deleted by switching address switch No. 3 to 1.

5-5. LOCKING CAPABILITY

5-6. If the minimum performance check, outlined in paragraph 3-4 fails or the instrument fails to lock at any frequency, then proceed as follows:

a. Remove top cover and basket cover.

b. Unplug AM/FM Modulation Board A7.

c. Set instrument under test to 10 GHz.

d. Set Spectrum Analyzer to 10 GHz, 100 MHz span.

e. If frequency error is greater than ±5 MHz, adjust A11R48 for ±3 MHz accuracy.

f. Set unit under test to 17 GHz.

g. If frequency error is greater than ±5 MHz, adjust A11R46 for ±3 MHz accuracy.

h. Repeat steps c through g until both frequencies are obtained.

i. Plug in Modulation Board A7 and and check for locking.

j. If problem persists, remove right lateral cover.

k. Disconnect A11J4 and A11J5.

l. Connect A11J5 to the Spectrum Analyzer with a frequency span from 8 MHz to 32 MHz.

m. Tune the unit under test from 17984000 kHz (23 MHz) to 18031999 kHz (8 MHz) with 10 kHz steps. Display at any frequency should be clean and locked.

n. If step m fails, check boards A2 or A3.

o. Connect A11J4 to the Spectrum Analyzer with a frequency span from 374 to 389 MHz.

p. Tune the unit under test from 10451000 kHz (388 MHz) to 10081000 kHz (374 MHz) in 10 MHz steps. In addition tune the unit to 1008000 (389 MHz).

q. If step p fails, check boards A4 or A5.

r. If steps m and p both fail, then check board A1.

5-7. SIGNAL PURITY

5-8. To perform the signal purity test, proceed as follows:

a. Remove top and right side cover.

b. Disconnect A11J5 and connect to the Spectrum Analyzer.

c. Set unit under test to 10 GHz.

d. Tune Spectrum Analyzer to 18 MHz.

e. Check phase noise at 10 kHz and 100 kHz.

f. If microwave signal phase noise is only 3 dB worse than the 18 MHz signal, then phase noise is produced by A2/A3. Otherwise replace A4 or A5 board.

g. If 400 kHz signals are greater than –65 dBc, then check power supply A8.

h. If 60, 120, 240, and 360 Hz are greater than the specifications, check the power supply A8 or grounds.

5-9. INCIDENTAL FM

5-10. The main cause of incidental FM is due to fan magnetic radiation and contact noise in potentiometers A11R46 and A11R48. Replace components if necessary.

5-11. R.F. OUTPUT

5-12. The RF attenuator has two pin attenuators that provide large and small steps. To perform the large step attenuation calibration, proceed as follows:

a. Set the POWER switch to its on position.

b. After countdown, set special test by momentarily switching switch "1" in the 8 switch gang at the top of the microprocessor board.

c. LEVEL indicator will show "001."

d. Press RF OFF key until the LEVEL indicator shows "012."

e. Connect the Spectrum Analyzer to the RF OUT connector.

f. Set the Spectrum Analyzer to 12 GHz and 100 Hz span. Use time base from Model 309 to lock the Spectrum Analyzer.

g. Press data input key "0" and FREQUENCY display will show "000."

h. Adjust pip in the Spectrum Analyzer to the middle of the screen and to the top of the screen (this level is zero reference).

i. Press MKR/CF key and the delta key in the Spectrum Analyzer.

j. Press data input key "4" and adjust A7R1 for −90 dB ±1 dB.

k. Press data input key "1" and adjust A7R3 for −5 dB ±0.1 dB.

l. Press data input key "2" and adjust A7R4 for −45 dB ±0.2 dB.

m. Press data input key "3" and adjust A7R7 for −74 dB ±0.3 dB.

n. Repeat steps g through m.

o. LSA driver is adjusted.

5-11. MODULATION

5-11.1 **AM Depth of Modulation and Distortion.** The amplitude modulation is accomplished by modulating the pin switch L.S.A. The L.S.A. has five steps of which only 0, −5, −45, and −74 dB are used. Before starting this procedure, check to see that the attenuation steps are in order.

a. Set unit under test to 12 GHz, 0 dBm level output, and 50% depth of modulation.

b. Modulate with an external signal of 10 kHz and 2 volts peak-to-peak.

c. Set the Spectrum Analyzer to 12 GHz, 100 kHz span.

d. Read delta dB between carrier modulation level (see Fig. 3-6) and distortion by utilizing technique in paragraph 3-11(3).

e. Adjust A7R2, if necessary.

f. Set unit under test to −50 dBm and adjust the Spectrum Analyzer level.

g. Read delta dB between carrier modulation level and distortion.

h. Adjust A7R5, if necessary.

i. Set unit under test to −80 dBm and adjust the Spectrum Analyzer level.

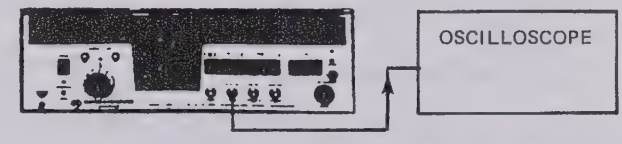
j. Adjust A7R7, if necessary.

k. If distortion test fails after step h, adjust A7R8 and A7R9 for minimum distortion.

5-11.2 **FM.** The FM rate generator covers the frequencies from 100 Hz to 200 kHz. This generator is used for sweep mode and pulse and has four ranges that extend from 0.01 Hz to 20 kHz. If accuracy fails during the minimum performance test, proceed as follows:

a. Measure voltage at TP1 for 12.8 volts. Adjust A7R23, if necessary.

b. Connect instrument as shown below.



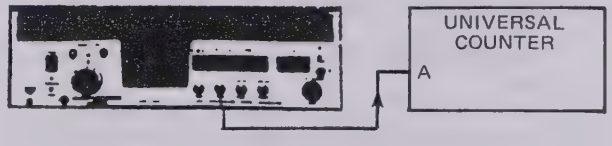
c. Set unit uncer test to 1 kHz range, 1 kHz DEV (FM Mode).

d. Observe waveform in scope.

e. If the waveform is not symmetrical, adjust A7R16.

f. Set unit under test to 50 Hz.

g. Connect instruments as shown below.



h. Set unit under test to 1 kHz rate.

i. Read counter.

j. Adjust A7R11, if necessary, for 1 kHz ±3 Hz.

k. Set unit under test to 150 kHz rate.

l. Adjust A7C20.

m. Repeat steps j and k.

n. Set unit under test to 100 Hz.

o. Adjust A7R13.

p. Repeat steps h through o.

q. Set unit under test to 0.1 Hz (Sweep Mode)

r. Connect instrument as in step b.

s. Use a stopwatch to read time. Adjust A7R14 to 0.1 Hz ±0.005 Hz.

t. If error exceeds 25%, reduce to 25% using A7R13.

Table

150 kHz	C20
1 kHz	R11
100 Hz	R13
0.1 Hz	R14

5-11.3 **External FM Alignment.** To align the external FM function, proceed as follows:

a. Connect a sinewave video generator, 2 volts peak-to-peak, 10 kHz to FM IN connector.

b. Connect an oscilloscope to A7P3 (A11J7 mate).

c. Set unit under test to EXT FM, 0.999 MHz DEV.

d. Adjust A7R10 for a 10 volt peak-to-peak ±0.01 volt on the scope. The offset of the sinewave at A7P3 should be less than 200 mV dc.

e. Set output of generator to "0" volts.

f. Adjust A7R108 for an output at A7P3 of 0.0 mV dc ±0.2 mV.

g. Set the unit under test to EXT FM, 1 MHz DEV.

h. Adjust A7R12 to 2 volts peak-to-peak on scope.

5-11.4 **Sweep Mode Adjustments.** To adjust the sweep mode, proceed as follows:

a. Connect an oscilloscope to A7P3 (A11J7 mate).

b. Set unit under test to 40 Hz, 2.500 GHz DEV.

c. Observe sawtooth on oscilloscope.

d. Adjust A7R20 for centering.

e. Adjust A7R19 to 9.0 volts peak-to-peak if necessary.

f. Connect instrument as shown in 5-11.2b.

g. Observe sawtooth on the oscilloscope.

h. Adjust A7R22 for baseline = 0 ±0.1 volt.

5-11.5 **Internal FM.** To adjust the internal FM, proceed as follows:

a. Connect an oscilloscope to A7P3 (A11J7 mate).

b. Set unit under test to 50 kHz rate, 0.5 MHz DEV.

c. Adjust A7R17 for 12.5 volts and center to ground with A7R18.

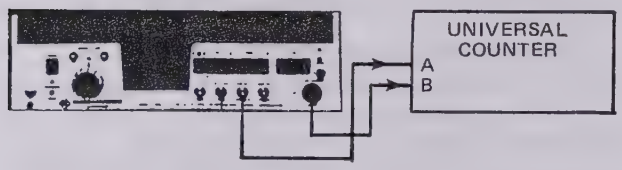
5-11.6 **List of Adjustments A7 Board**

R1	Final adjustment made in system to match PIN	500 ohms
R2–R7	Adjustment made with a Standard Dummy Test Load (which simulates the typical PIN ATT load)	
R2	(–5 dB) adjust with modulation	500 K
R3	(–5 dB) fixed attenuation	1 Meg
R4	(–45 dB) fixed attenuation	50 K
R5	(–45 dB) adjust with modulation	200 K
R6	(–74 dB) fixed attenuation	20 K
R7	(–74 dB) adjust with modulation	100 K
R8	AM Mod Shape Adj, input	2 K
R9	AM Mod Shape Adj, output	2 K
R10	FM and ΔF output DAC gain adj	5K
R11	1 kHz adjustment	100 K
R12	–5 adjustment	500 ohm
R13	Low frequency adjustment	20 K
R14	Band I adjustment	50 K
R15	Low range symmetry adjustment	2K
R16	High range symmetry adjustment	200 ohm
R17	Sinewave output level	2 K
R18	Sinewave centering	50 K
R19	ΔF (sawtooth) level control	2 K

R20	ΔF (sawtooth) centering control	50 K
R21	FM and ΔF deviation zero level control .	50 K
R22	ΔF (sawtooth) output baseline adj.	20 K
R23	−2.8 volt adjustment	10K
R108	Large signal zero adjustment	20 K
C20	200 kHz adjustment.	5.1 to 50 PF

5-12. **Pulse Modulator Board A6 Alignment.** To align the delay and pulse circuitries of the pulse modulator board A6, proceed as follows:

a. Connect instrument as shown below.



b. Set the unit under test to 7 GHz, 15 dBm approximately, 0.06 kHz rate, 5 μs pulse width, 9990 μs pulse delay.

c. Press the level key in the counter and adjust channel A level knob until flashing stops. Read level. (should read approximately 3.8 V).

d. Adjust channel level A knob until it reads half of the value obtained in step c.

e. Press the A-B keys.

f. Slowly adjust the channel B knob until it flashes.

g. Display reads delay time.

h. Adjust A6R29 until it reads just over 10 ms, −0 +2%.

i. Step delay to 999, 100, 99.9, 10 μs and look for overlap values between ranges.

j. Set the unit under test to 0.99 μs and adjust A6C12 for approximately 1 μs.

k. Set unit under test to 0.1 μs and check if delay time is within specification.

l. Set unit under test to 99.9 μs and adjust A6C14 for approximately 10 μs.

m. Set unit under test to 1 μs and check if delay time is within specification.

n. Check all extreme values in each range and look for slight overlap between ranges.

o. Connect instruments as shown in para. 5-11.2g.

p. Set unit under test to 5 μs delay, 999 μs pulse width.

q. Set Channel A to Z = 50 ohms, slope Z, and press pulse A.

r. Adjust level knob of channel A very slowly until the light flashes. Display reads pulse width.

s. Adjust A6R41 until it reads approximately 1 ms, −0, +2%.

t. Step width to 99.9, 10, 9.99, and 1 μs and look for overlap values between ranges.

u. Set unit under test to 90 ns and adjust A6C32. Set instrument to 0.02 μs and check if it is within specification.

v. Set unit under test to 99.0 μs and adjust A6C34. Set the instrument to 0.1 μs and check if it is within specification.

w. Check all extreme values in each range and look for small overlap of values between ranges.

5-13. RF Head A11 Adjustments (Fig 5-1)

5-14. **Sweep Mode.** To perform the sweep mode adjustment proceed as follows:

a. Connect a Spectrum Analyzer to the RF OUT connector of the unit under test.

b. Remove the A7 board from the instrument.

c. Set the POWER switch to its on position and set 10 GHz, 10 dBm and "0" DEV (sweep mode).

d. Set the spectrum analyzer to 10 GHz and 100 MHz span.

e. If pip is over 5 MHz off, adjust A11R48.

f. Clear "0" DEV (▲, CL MOD) (signal lock).

g. Disconnect A11J7 from R.F. Head.

h. Set Spectrum Analyzer to 200 MHz span.

J1: RF output, 50Ω, VSWR 2:1, maximum output >+12 dBm.

J2: Pulse input +1, −9V driven from 22Ω impedance.

J3: Input to LSA and AM signal.

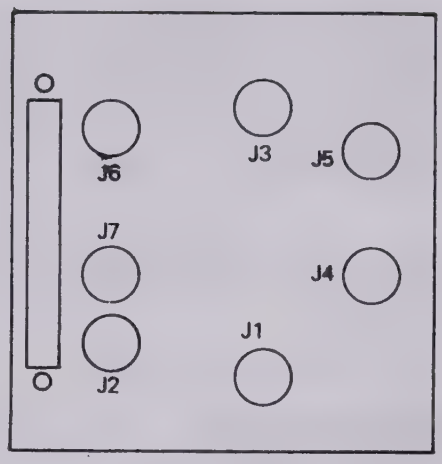
J4: Input from Loop No. 3B, 50Ω, 0 dBm.

J5: Input from Loop No. 2, 50Ω, 0 dBm.

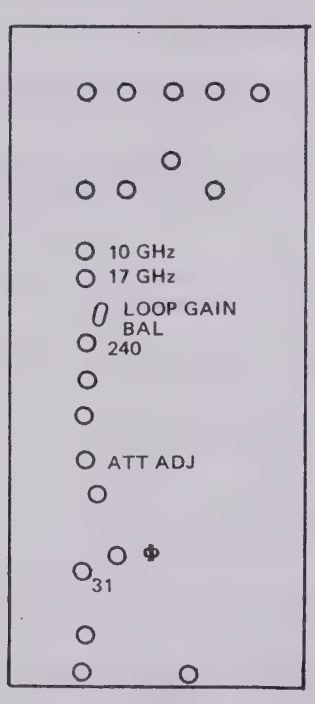
J6: EXT. DETECTOR and Flyback Pulse, −100 mV

J7: FM input, <±5 V

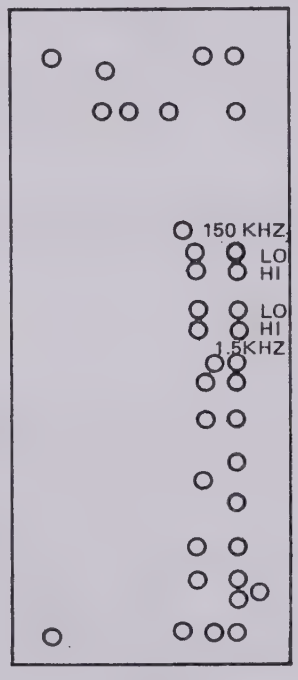
Ribbon Connector: Power supplies, digital signals.



FRONT



TOP



BOTTOM

A11R48 . . .10 GHz
A11R46 . . .17 GHz
A11R18 . . .LOOP GAIN
A11R15 . . .BAL
A11R77 . . .ATT ADJ
A11R4 . . . .Φ DET

FREQ	BAND	ADJ
200 kHz	.LO	.A11R85
200 kHz	.HI	.A11R86
2 kHz	.LO	.A11R84
2 kHz	.HI	.A11R83

Figure 5-1. RF Head A11 Adjustments And Input And Output Connectors

i. If FM search is unsymmetrical from 10 GHz, adjust A11R15.

j. Reconnect A11J5.

k. Connect a 10 kHz, 5 volt peak signal to A11J7.

l. Set SP FM (▲,"1"), 10 MHz DEV, EXT FM.

m. Adjust A11R38 for a ±10 MHz modulation.

5-15. **External FM**

a. Reconnect connector from basket to A11J7.

b. Connect an Audio Generator to FM IN of the unit under test with the Audio Generator output "OFF."

c. Connect unit under test time base output to time base input of Spectrum Analyzer.

d. Set 0.68 MHz DEV, EXT FM.

e. Set Audio Generator to 5 ohms output impedance and 2 kHz rate.

f. Set Audio Generator to 7.07 mV peak-to-peak (5 mV rms).

g. Adjust A11R83 for deepest carrier null (5 ohms output).

h. Set Audio Generator to 707 mV peak-to-peak (500 mV rms) and 200 kHz rate.

i. Adjust A11R86 for deepest carrier null.

j. Repeat steps d through i.

k. Set unit under test to 1.02 MHz DEV.

l. Set Audio Generator to 4.25 mV peak-to-peak (3 mV rms) and 2kHz rate (5 ohms output).

m. Adjust A11R84 for deepest carrier null.

n. Set Audio Generator for 425 mv peak-to-peak (300 mV rms) and 200 kHz rate.

o. Adjust A11R85 for deepest carrier null.

p. Repeat steps k through o.

5-16. **Phase Detector Alignment.** This procedure aligns the No. 4 Loop detector.

a. Connect time bases between the unit under test and the Spectrum Analyzer.

b. Set the unit under test to 17983999 GHz and 10 dBm output.

c. Set Spectrum Analyzer to same frequency and C.F. step size to 4 MHz.

d. Set Spectrum Analyzer to 50 kHz span and center the pip on the screen.

e. Adjust A11R34 until reference frequency is visible.

f. Reduce span of the Spectrum Analyzer to minimize centering the reference on the screen.

g. Adjust A11R34 until minimum reference is seen on the screen.

5-17. **Loop 3B Board A5 Adjustments**

5-18. To perform the Loop 3B Board A5 adjustments proceed as follows:

a. Place the Loop 3B Board A5 on Extender Board.

b. Connect a Spectrum Analyzer to the RF OUT connector.

c. Set frequency to 11.8 GHz and output level to 10 dBm.

d. Set Spectrum Analyzer to 11.8 GHz and set span for 1 MHz.

e. Connect a probe from a DC Voltmeter to A5TP2 through the opening on the top of the metal shield.

f. Tune A5C53 through the opening located on the front of the metal shield.

g. Adjust A5C53 until the Voltmeter reads 2.3 volts.

h. Observe the 400 kHz spurious on the Spectrum Analyzer and readjust A5C53 until the 400 kHz spurious are minimum. Voltmeter should read values between 2 to 3.2 volts.

i. Set frequencies between 11.9 and 12.3 GHz in 10 MHz steps and observe the Spectrum Analyzer to verify frequency locked operation.

5-19. **RF Head Exchange**

5-20. This alignment procedure applies when the RF Head A11 is replaced or when some areas of the attenuation range are noticeably in error.

a. Connect a Spectrum Analyzer to the RF OUT connector and tune to 12 GHz.

b. Switch unit to "Special Test # 12." The FREQUENCY indicator will indicate the selected step.

c. Set the selected step using the DATA INPUT keys (1 = 0 dB, 2 = –5 dB, 3 = –45 dB, 4 = –74 dB, and 5 = –90 dB).

d. Center the signal in the Spectrum Analyzer with 100 Hz sweep width and set function in the Spectrum Analyzer for relative levels.

e. Set –90 dB on the keyboard and adjust A7R1 for a 90 dB signal drop in the spectrum Analyzer. Set –5 dB and adjust A7R3. Set –45 dB and adjust A7R4. Set –74 dB and adjust A7R6.

f. Repeat step e.

g. In the event that some of the LEVEL readings are out of specification, proceed as follows:

(1) Set the unit output to 12 GHz.

(2) Decrease attenuation in 1 dB steps from the maximum output.

(3) When attenuation approaches 5 dB, it may have a larger step. Reduce this step to 0.1 dB.

(4) When attenuation approaches –40 dB, it may have a larger step. Adjust A7R4 to reduce this step to 0.01 dB.

(5) When attenuation approaches –70 dBm, it may have a larger step. Adjust A7R6 to reduce this step to 0.1 dB.

h. For other adjustments refer to paragraph 5-13.

5-21 TROUBLESHOOTING

5-22. Prior to any module troubleshooting check for any error code messages. Refer to paragraph 5-3 and Table 5-1 and make sure that the ADDRESS switch is in the 0 position.

5-23. **Power Supply.** Measure the voltages at the test points listed below under operating conditions and compare measured values to those listed below.

Connector	Pin	Voltage	
A10A1J1	4	+15.0 V	±0.75 V
A10A1J1	10	–15.0 V	±0.75 V
A10A1J1	12	+10.5 V	±0.50 V
A10A1J1	35	+ 5.0 V	±0.25 V

Note: For troubleshooting as needed, first check the +5 V power supply and then individual regulators for +15, –15, and +10.5 volt power supplies.

5-23. **Reference Frequency Generator Board Assy A1.** To troubleshoot the A1 Reference Frequency Generator Board Assy A1, use an Extender Board for ease of accesibilty. Check the following outputs:

P1	1 MHz	TTL level
P5	25 kHz	TTL level
P3	400 MHz	0 to –6 dBm level
TP1	DC voltage	+5 to +11 vdc
	(If this voltage is not obtained for TP1 voltage, adjust T1 for ~8 vdc reading).	

5-25. **Loop No. 2 Component Board Assy A3.** To troubleshoot the Loop No. 2 Component Board Assy A3, use an Extender Board for ease of accessiblity and proceed as follows:

a. Set front panel display for 10 GHz and 0 dBm output.

b. Read the frequencies at P3 using a Frequency Counter. Frequency at P3 should be 18 MHz.

c. Refer to Table 5-2 for verification of proper frequency operation.

5-26. **Loop No. 2 Divider Board Assy A2.** To troubleshoot the Loop No. 2 Divider Board Assy A2, use an Extender Board for ease of accessibilty and proceed as follows:

a. Set front panel display to first frequency reading (17984000) in Table 5-2.

TABLE 5-2. FREQUENCY VERIFICATION

	Front Panel Frequency Setting (GHz)	P2 Frequency Output (MHz)	P3 Frequency Output (kHz)	Band	Loop No. 2 Divider	3A Frequency Output (MHz)	3B Frequency Output (MHz)
1	17984000	40.0000	8000.0	I	1600.0	32.000	376
2	17976001	59.9975	11999.5	I	2399.9	11.9995	375
3	17976000	60.0000	12000.0	II	2400.0	12.0000	375
4	17962001	94.9975	18999.5	II	3799.9	18.9995	375
5	17962000	95.0000	19000.0	III	3800.0	19.0000	375
6	17944001	139.9975	27999.5	III	5599.9	27.9995	375
7	17944000	140.0000	28000.0	IV	5600.0	28.0000	375
8	17936000	160.0000	32000.0	IV	6400.9	32.0000	375

b. Disconnect Loop No. 2 Component Board Assy A3.

c. Provide external signal (40 MHz at 0 dBm) to A3P2. Refer to Table 5-2 for A3P2 signal.

d. Connect a Frequency Counter to A3P4 and read frequency output. Frequency should be 25 kHz.

e. Utilizing Table 5-2, follow the same procedure to obtain 25 kHz at A3P2.

5-27. **Loop No. 3A Board Assy A4.** To troubleshoot Loop No. 3A Board Assy A4 use an Extender Board for ease of accessibility and proceed as follows:

a. 0 output at A4P2 should be 36 to 52 MHz with 1 MHz step size.

b. Utilizing Table 5-2, obtain the proper frequency output at A4P2.

c. If there is a locking problem or wrong frequency output refer tp paragraphs 4-18 and 5-5.

5-28. **Loop No. 3B Board Assy A5.** To troubleshoot Loop No. 3B Board Assy A5, use an Extender Board for ease of accessibility and proceed as follows:

a. Input signal at A5P1 and A5P2 from Loop No. 3A Board Assy A4 should be correct since these outputs were checked previously.

b. Monitor output at A5P5. Refer to Table 5-2 for proper settings and proper operational frequencies.

5-29. **Pulse Modulator Board Assy A6.** To troubleshoot Pulse Modulation Board Assy A6, proceed as follows:

a. Pulse Delay

(1). Connect a High Frequency Detector to the RF OUT connector of the unit.

(2). Connect the output of the High Frequency Detector to a Universal Counter, Channel B.

(3). Connect SYNC OUT connector of unit to a Universal Counter, Channel A.

(4). Set RATE kHz switch for a reading of 0.06 kHz.

(5). Set DELAY μs switch for a reading of 1 μsec.

(6). Display on Universal Counter should read 1 μsec ±10%.

(7). To check any other delay setting, simply change delay settings using the DELAY μs switch and verify the readings on the Universal Counter.

Note: The thresholds on channels A and B of the Universal Counter should be set to 50%.

b. Pulse Width

(1). Connect a High Frequency Detector to the RF OUT connector of the unit.

(2). Connect the output of the High Frequency Detector to a Universal Counter, Channel A.

(3). Set the DELAY μs switch for a reading of 1 μsec.

(4). Display on Universal Counter should read

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Maintenance

1 μsec ±10%.

Note : The threshold on channel A should be 50%.

(5). If troubleshooting is required, use an Extender Board for ease of accessibility and proceed as follows:

(6). Verify that variable dc voltages are obtained from A6U10, pins 1 and 7. These voltages are variable depending upon the delay and width setting. Typical range is from +1 to +10 vdc.

(7). Verify that pulses are obtained from A6U12, pin 6, and verify that proper inversions exist at A6Q18, A6Q19, and A6Q9. Also verify dc operation between A6Q9 and A6U12, pin 1.

5-30. **AM/FM Modulation Board Assy A7.** To troubleshoot the AM/FM Modulation Board Assy A7 use an Extender Board for ease of accessibility and proceed as follows:

a. Rate.

(1). Connect a Frequency Counter to A7P3.

(2). Set RATE kHz switch for a reading of 150 kHz.

(3). Set FM to 200 kHz DEV.

(4). Check for a reading of 150 kHz at A7P3.

(5). For any other RATE kHz setting, enter desired rate and check frequency at A7P3.

(6). If improper operation is detected, check A7U13 (function generator) and A7U12 and A7U13 (band switch). Refer to paragraph 5-11.2 for proper alignment procedures.

b. DEVIATION

(1). Connect an Oscilloscope to A7P3.

(2). Set RATE kHz to 10 kHz.

(3). Set DEV MHz to 0.999 MHz.

(4). Observe a sinewave signal at A7P3. Peak-to-peak voltage should be 10V (-5 to +5).

(5). For improper operation, check the signal path from A7U13 to A7U12, A7U24, A7U20, A7U23, and A7U25. Refer to paragraphs 5-11.2 thru 5-11.6 for adjustment procedures.

c. AM

(1). Connect a 2v peak-to-peak, 0 kHz sinewave signal to the AM IN connector of the unit.

(2). Clear modulation.

(3). Set 70% AM modulation.

(4). Set power level to 0 dBm.

(5). Connect A7P5 to an Oscilloscope. The signal viewed on the Oscilloscope should be a distorted sinewave.

(6). If improper operation is detected check the signal path from A7U1 through A7U6, A7U7, A7U10, A7U14, A7U18, A7U19, and A7U15 and associated circuitry. Also check pin diode switch circuit. Refer to paragraph 5-11.1 for adjustment procedure.

5-31. **RF Head A11.** This module is a sealed unit and only minor adjustments can be made. The RF Head should be returned to the factory for any repairs and adjustments.

5-32. To determine the extent of repairs required, check the signal coming to connectors A11J4 and A11J5. The "hot" side of connector A11J7 must be grounded. If these three connectors have normal signals, the lock indicator in the RF Head A11 should light. Connectors A11J3 and A11J5 are the inputs pin diode units (LSA and Pulse Modulations). Both units have diodes parallel to ground, with cathodes grounded. Maximum positive signal is 60 ma and the maximum negative signal is –9 volts. For a 0.999 MHz FM deviation, the voltage in A11J7 should be ±5 volts. A11J6 controls the level output when in EXT DET mode for negative voltages less than 0.5 volts. If the input signals are inside the specified limits and the unit does not meet general specifications, adjust the RF Head as outlined in paragraph 5-13 or exchange the module as necessary.

SECTION VI

PARTS LIST

6-1. INTRODUCTION

6-2. This parts list provides an alpha-numerical listing in reference symbol sequence of the replaceable electrical, certain electro-mechanical, and mechanical parts of the unit.

6-3. ORDERING INFORMATION. Orders for parts should contain the following information:

a. Equipment name and model number.
b. Serial number.
c. Reference symbol of part, if applicable.
d. Manufacturer's part number and code.

6-4. HOW TO USE THE PARTS LIST

6-5. An explanation of the structure of the parts list, table 6-2, and the meaning of the entries in the five columns are given in the following paragraphs. (See figure 6-1.)

6-6. REFERENCE SYMBOL COLUMN. The reference symbol column (1, figure 6-1) contains the reference symbol number assigned to each part, which also identifies the part on the schematic diagram or illustration. The listing is in alpha-numerical order.

6-7. DESCRIPTION COLUMN. The description column (2) contains a brief description of each part.

6-8. MANUFACTURER'S PART NUMBER COLUMN. The manufacturer's part number column (3) contains the part number assigned by the manufacturer of the part.

6-9. MANUFACTURER'S CODE COLUMN. The manufacturer's code column (4) contains a five digit code identifying the manufacturer of the part. Table 6-1 contains a listing of the five digit codes and the manufacturer's names and addresses.

6-10. QUANTITY COLUMN. The quantity column (5) indicates the quantity of each part contained in the respective assembly or subassembly of the instrument.

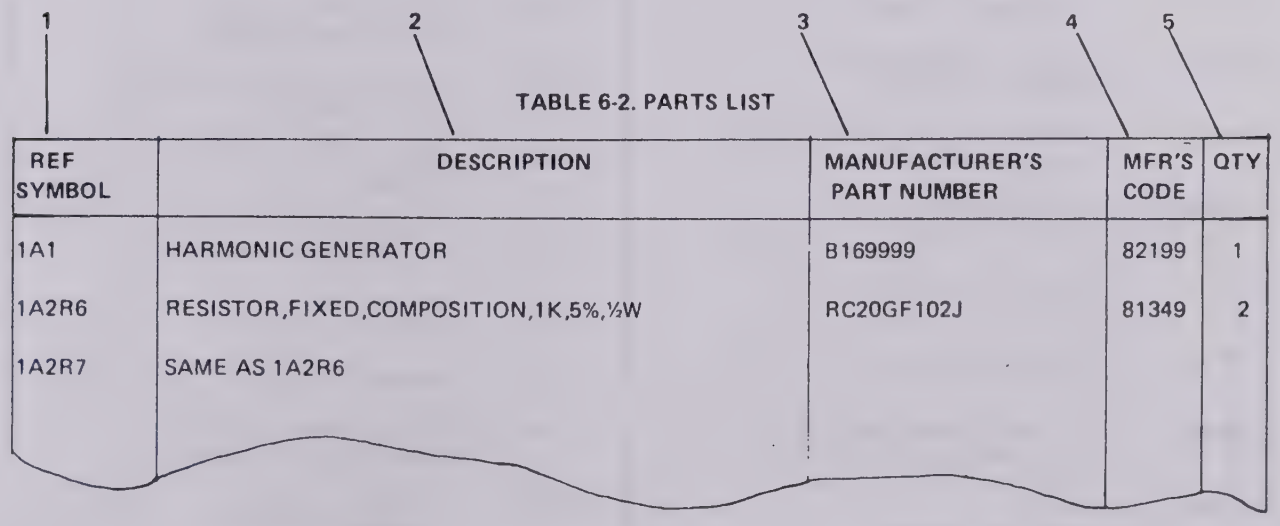

Figure 6-1. Parts List Example

TABLE 6-2. LIST OF MANUFACTURERS

Code	Name and Address
01295	Texas Instruments, Inc. Semiconductor Division Dallas, TX 75231
04713	Motorola Semiconductor Products, Inc. Phoenix, AZ 85008
04761	Clare Division General Instrument Corp. Chicago. IL 60645
05245	Corcom, Inc. Libertyville, IL 60048
10389	Licon Division Illinois Tool Works Chicago, IL 60647
11237	CTS Electronics Corp. Pasa Robles, CA 93446
12629	Unitrode Corp. Lexington, MA 02713
13103	Thermalloy Corp. Dallas, TX 75381
13715	Fairchild Camera and Instrument Corp. San Rafael, CA 94902
14583	Plessey Electro-Products, Inc. Los Angeles, CA 90066
15542	Minicircuits Laboratories, Inc. Brooklyn, NY 11235
24355	Analog Devices, Inc. Cambridge, MA 02142
26742	Methode Electronics, Inc. Chicago, IL 60656
27735	F-Dyne Electronics Corp. Bridgeport, CT 06605
28480	Hewlett-Packard Corp. Palo Alto, CA 94304
29990	American Technical Ceramics, Inc. Huntington Station, NY 11746
31148	PMI Corp. Sacramento, CA 95813
34649	Intel Corp. Santa Clara, CA 95005
36482	National Semiconductor Corp. Montreal, Canada
37942	P.R. Mallory and Co. Indianapolis, IN 46206
49671	RCA New York, NY 10020
56289	Sprague Electronics Corp. North Adams, MA 01247
59660	Tusonix, Inc. Tuscon, AZ 85745
61449	International Components Corp. Warwick, RI 61638
61892	Hitachi America Ltd. San Jose, CA 95122
62703	Varo Semiconductors, Inc. Garland, TX 75040
62786	NEC Electronics USA, Inc. Natick, MA 01760
71590	Centralab Division Globe Warner Corp. Milwaukee, WI 53201
71895	Delevan Mfg. Co. Des Moines, IA 50265
72982	Erie Technology Products, Inc. Erie, PA 16512
73445	Amperex Electronics Corp. Hicksville, NY 16512
77342	American Machine and Foundary Princeton, NJ 47570
81073	Grayhill, Inc. La Grange, IL 60525
81349	Military Specifications
82199	Rohde & Schwarz-Polarad, Lake Success, NY 11042
84171	Arco Electronics, Inc. Commack, NY 11725
84411	TRW Capacitor Division Oglalla, NE 69153

TABLE 6-2. LIST OF MANUFACTURERS (Cont'd)

Code	Name and Address	Code	Name and Address
91293	Johansen Mfg. Co. Boonton, NJ 07005	C1011	Schurter GMBH Endigen, West Germany
91506	Augat Inc. Attleboro, MA 02703	C1213	Radiall GMBH Sprendlingen, West Germany
91873	Keystone Electronics, Inc. New York, NY 10012	S5175	Panasonics Tokyo, Japan
95121	Quality Components Corp. St. Mary's, PA 15857	U2024	Intersil Basingstoke Hants, England
98921	Sealectro Corp. Mamaroneck, NY 10544		

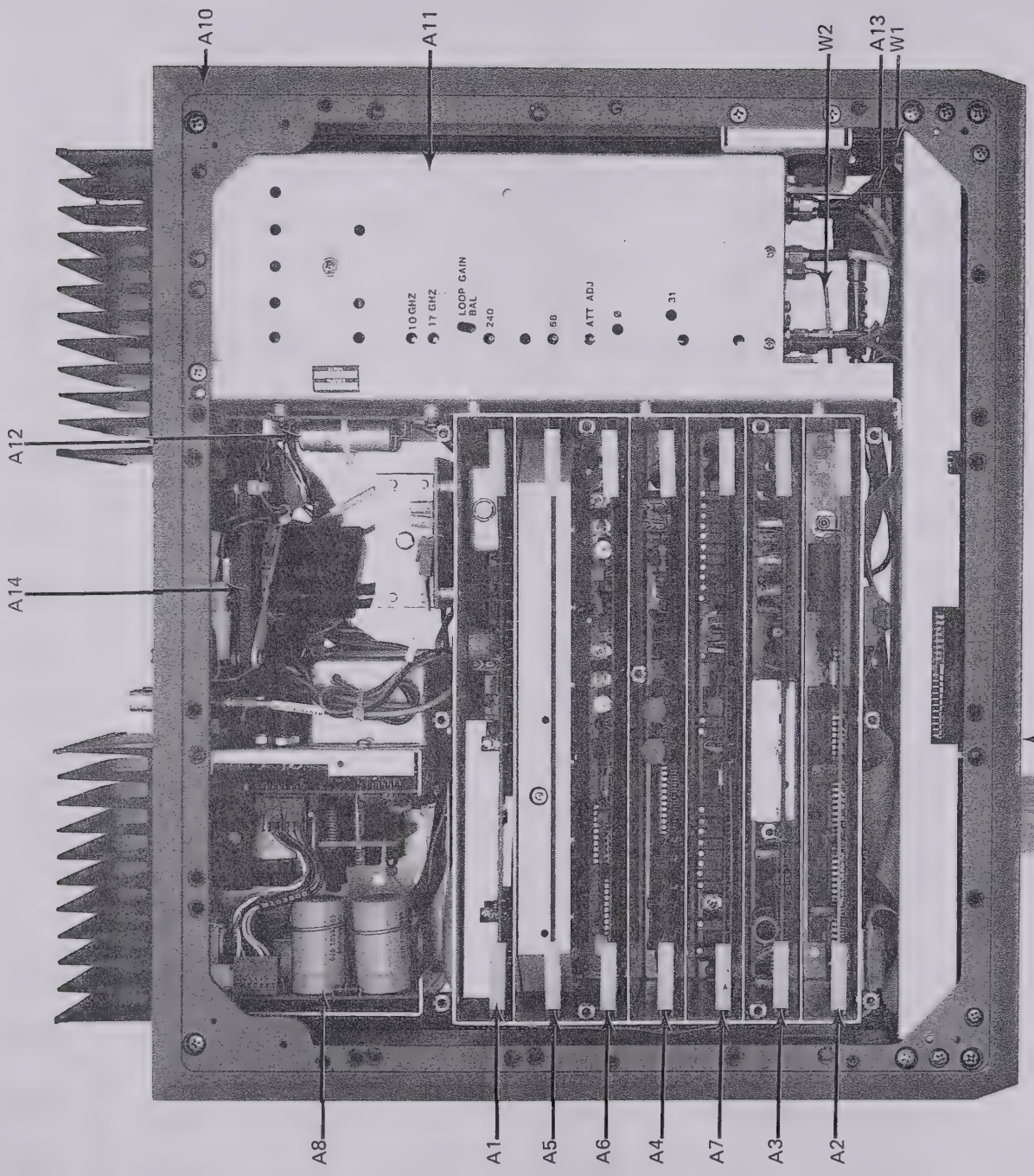

Figure 6-2. Synthesisized Microwave Signal Generator Model 309, Parts Location

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
	SYNTHESIZED MICROWAVE SIGNAL GENERATOR MODEL 309 (See Fig. 6-2)	**163274**	**82199**	
A1	Reference Frequency Generator Board Assembly	163021-4	82199	1
A2	Loop No. 2 Divider Board Assembly	163039	82199	1
A3	1 kHz Loop Board Assembly	163036-2	82199	1
A4	Loop No. 3A Board Assembly	163027	82199	1
A5	Loop No. 3B Board Assembly	163172	82199	1
A6	Pulse Modulation Board Assembly	163250	82199	1
A7	AM/FM Modulation Board Assembly	163152	82199	1
A8	Power Supply Assembly	163251	82199	1
A9	Front Panel Assembly	163247	82199	1
A10	Frame Assembly	163246	82199	1
A11	RF Module Assembly (Non-Repairable Assy)	163291	82199	1
A12	Filter Board Assembly	163463	82199	1
A13	Isolator-Connector Assembly	163457-2	82199	1
A14	Time Base Assembly	163454	82199	1
W1	RF Cable Assembly	163273	82199	1
W2	Cable Assembly	163522	82199	1

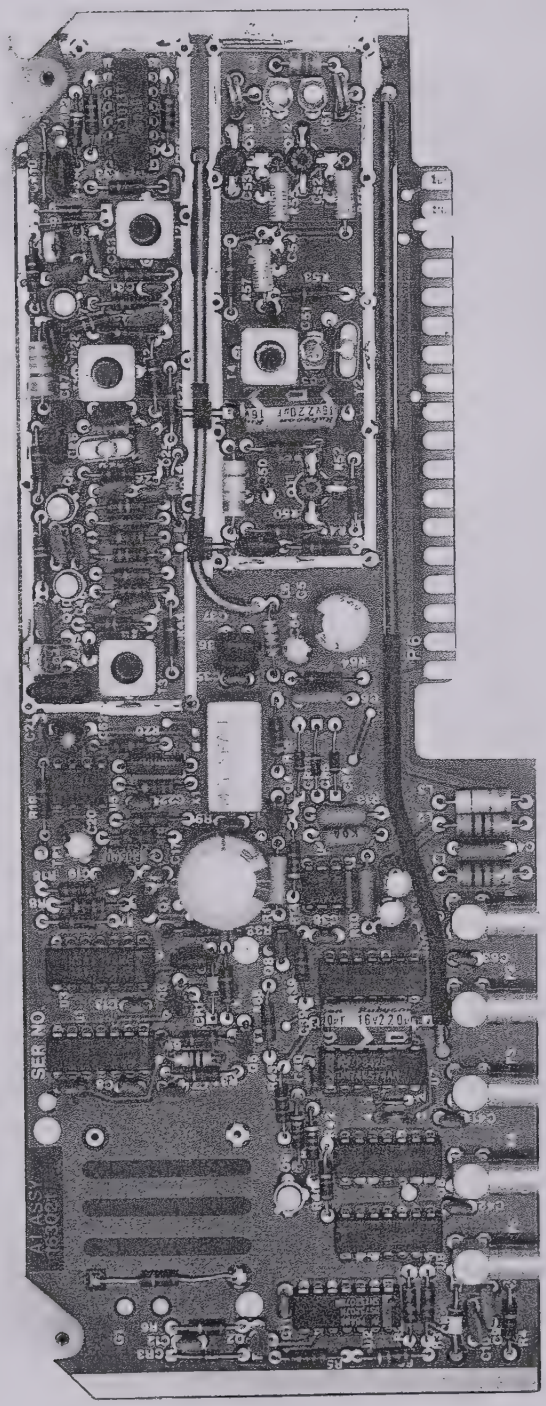

Figure 6-3. Reference Frequency Generator Board Assembly A1, Parts Location

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A1	**REFERENCE FREQUENCY GENERATOR BOARD ASSEMBLY (See Fig. 6-3)**	**1630321-4**	**82199**	**1**
A1C1	Capacitor, Fixed, Electrolytic, 10 UF, 35 WVDC	VTL10S35	37942	4
A1C2	Capacitor, Fixed, Ceramic, 0.001 UF, 1000 WVDC	CCD-102	84171	14
A1C3	Same as A1C1			
A1C4	Capacitor, Fixed, Monolythic, 2.2UF, 50 WVDC	3C37Z5U225M050B	56289	2
A1C5	Capacitor, Fixed, Electrolytic, 16 WVDC	16TWMS470UF	37942	1
A1C6	Same as A1C4			
A1C7	Capacitor, Fixed, Ceramic, 0.1 UF, 100 WVDC	RPE121Z5U104M	72982	20
A1C8	Same as A1C7			
A1C9	Same as A1C2			
A1C10	Same as A1C2			
A1C11	Same as A1C7			
A1C12	Same as A1C7			
A1C13	Same as A1C7			
A1C14	Same as A1C7			
A1C15	Same as A1C7			
A1C16	Capacitor, Fixed, Mica, 51 PF	CM04ED510J03	81349	1
A1C17	Capacitor, Fixed, Electrolytic, 1000 UF, 16 WVDC	MS16-1000M-16V	37942	1
A1C19	Same as A1C2			
A1C20	Same as A1C1			
A1C21	Same as A1C7			
A1C22	Same as A1C7			
A1C23	Same as A1C2			
A1C24	Same as A1C2			
A1C25	Same as A1C2			
A1C26	Same as A1C7			
A1C27	Same as A1C2			
A1C28	Capacitor, Fixed, Mica, 5PF	CM04CD050D03	81349	1
A1C29	Same as A1C2			
A1C30	Same as A1C2			
A1C31	Same as A1C7			
A1C32	Capacitor, Variable, 1.5-4 PF	GKU4R006	56289	1
A1C33	Same as A1C2			
A1C34	Capacitor, Fixed, Mica, 120 PF	CM04CD121J03	81349	1
A1C35	Same as A1C7			
A1C36	Capacitor, Fixed, Mica, 330 PF	CM04FA331J03	81349	2
A1C37	Same as A1C36			
A1C38	Same as A1C7			
A1C39	Capacitor, Fixed, Electrolytic, 220 UF, 16 WVDC	900040-01	82199	2
A1C40	Same as A1C7			
A1C41	Same as A1C7			
A1C42	Same as A1C7			
A1C43	Capacitor, Fixed, Ceramic, 0.001 UF, 100 WVDC	RPE121COG102J	72982	5
A1C44	Same as A1C2			
A1C45	Same as A1C2			
A1C46	Same as A1C7			
A1C47	Same as A1C2			
A1C48	Capacitor, Variable, 2.8-10 PF	GKU10006	56289	1
A1C49	Capacitor, Fixed, Mica, 10 PF	CM04CD100D03	81349	1

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A1C50	Same as A1C43			
A1C51	Capacitor, Variable, 2.8-10 PF	GKU10000	56289	3
A1C52	Same as A1C43			
A1C53	Same as A1C43			
A1C54	Same as A1C43			
A1C56	Capacitor, Fixed, Ceramic, 0.047 UF, 10 WVDC	RPE121Z5U473M	72982	1
A1C59	Capacitor, Fixed, Metallic, 0.47 PF, 5%	MC.47PF,5%	95121	1
A1C60	Same as A1C51			
A1C61	Same as A1C51			
A1C62	Capacitor, Fixed, Electrolytic, 10 UF, 20 WVDC	TDC106K020NLF	37942	1
A1C64	Same as A1C1			
A1C65	Same as A1C39			
A1CR1	Semiconductor Device, Diode	1N5242B	81349	1
A1CR2	Semiconductor Device, Diode	1N4733A	81349	1
A1CR3	Semiconductor Device, Diode	1N914	81349	2
A1CR4	Semiconductor Device, Diode	1N456A	81349	3
A1CR5	Same as A1CR4			
A1CR6	Semiconductor Device, Diode	MV209	04713	2
A1CR7	Same as A1CR6			
A1CR8	Semiconductor Device, Diode	1N5711	81349	2
A1CR9	Same as A1CR8			
A1CR10	Same as A1CR3			
A1CR13	Same as A1CR4			
A1CR14	Semiconductor Device, Diode	1N4742A	81349	1
A1DS1	Light Emitting Diode	SRL035.1350	C1011	1
A1L1	Coil, RF	1537-36	71895	2
A1L2	Same as A1L1			
A1L3	Coil, RF	1537-06	71895	2
A1L5	Coil, RF	1537-22	71895	1
A1L6	Coil, RF	1025-24	71895	1
A1L7	Same as A1L3			
A1L9	Coil, RF	163367	82199	2
A1L10	Same as A1L9			
A1L11	Coil, RF	1025-08	71895	1
A1L12	Coil, RF	1025-44	71895	1
A1P1	Connector	115666	C1213	5
A1P2	Same as A1P1			
A1P3	Same as A1P1			
A1P4	Same as A1P1			
A1P5	Same as A1P1			
A1Q1	Transistor	2N4400	81349	4
A1Q2	Transistor	2N4402	81349	2
A1Q3	Same as A1Q1			
A1Q4	Same as A1Q1			
A1Q5	Same as A1Q1			
A1Q6	Transistor	40600	49671	3
A1Q7	Same as A1Q6			
A1Q8	Same as A1Q2			
A1Q9	Transistor	2N2369A	81349	1
A1Q10	Same as A1Q6			
A1Q11	Transistor	BFR91	73445	3

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A1Q12	Same as A1Q11			
A1Q13	Same as A1Q11			
A1R2	Resistor, Fixed, Composition, 51 Ohms, 5%, ¼W	RC07GF510J	81349	6
A1R3	Same as A1R2			
A1R4	Resistor, Fixed, Composition, 1 K, 5%, ¼W	RC07GF102J	81349	5
A1R5	Resistor, Fixed, Composition, 160 Ohms, 5%, ¼W	RC07GF161J	81349	1
A1R6	Resistor, Fixed, Composition, 2K, 5%, ¼W	RC07GF202J	81349	2
A1R7	Same as A1R4			
A1R8	Resistor, Fixed, Composition, 680 Ohms, 5%, ¼W	RC07GF681J	81349	2
A1R9	Same as A1R2			
A1R10	Resistor, Fixed, Film, 9.09K, 1%, ¼W	RN60D9091F	81349	2
A1R11	Resistor, Fixed, Film, 4.53K, 1%, ¼W	RN60D4531F	81349	1
A1R12	Resistor, Fixed, Film, 1%, ¼W	RN60D3321F	81349	1
A1R13	Same as A1R10			
A1R14	Resistor, Fixed, Composition, 4.7K, 5%, ¼W	RC07GF472J	81349	1
A1R15	Resistor, Fixed, Composition, 470 Ohms, 5%, ¼W	RC07GF471J	81349	1
A1R16	Resistor, Fixed, Film, 1K, 1%, ¼W	RN60D1001F	81349	1
A1R17	Resistor, Fixed, Film, 51.K, 1%, ¼W	RN60D5112F	81349	1
A1R18	Resistor, Fixed, Composition, 300 Ohms, 5%, ¼W	RC07GF301J	81349	1
A1R19	Resistor, Fixed, Composition, 10K, 5%, ¼W	RC07GF103J	81349	5
A1R20	Same as A1R2			
A1R21	Same as A1R2			
A1R22	Same as A1R19			
A1R23	Resistor, Fixed, Composition, 100K, 5%, ¼W	RC07GF104J	81349	5
A1R24	Same as A1R19			
A1R25	Resistor, Fixed, Composition, 33K, 5%, ¼W	RC07GF333J	81349	3
A1R26	Resistor, Fixed, Composition, 270 Ohms, 5%, ¼W	RC07GF271J	81349	3
A1R27	Resistor, Fixed, Composition, 100 Ohms, 5%, ¼W	RC07GF101J	81349	7
A1R29	Same as A1R19			
A1R30	Same as A1R25			
A1R31	Same as A1R26			
A1R32	Same as A1R27			
A1R33	Same as A1R27			
A1R34	Resistor, Fixed, Composition, 200 Ohms, 5%, ¼W	RC07GF201J	81349	1
A1R35	Resistor, Fixed, Composition, 1.8K, 5%, ¼W	RC07GF182J	81349	1
A1R36	Same as A1R8			
A1R37	Same as A1R27			
A1R38	Same as A1R27			
A1R39	Resistor, Fixed, Composition, 51K, 5%, ¼W	RC07GF513J	81349	2
A1R40	Resistor, Fixed, Composition, 510 Ohms, 5%, ¼W	RC07GF511J	81349	2
A1R41	Same as A1R40			
A1R42	Resistor, Fixed, Composition, 620 Ohms, 5%, ¼W	RC07GF621J	81349	1
A1R43	Resistor, Fixed, Composition, 150 Ohms, 5%, ¼W	RC07GF151J	81349	1
A1R44	Same as A1R27			
A1R45	Resistor, Fixed, Composition, 220K, 5%, ¼W	RC07GF224J	81349	1
A1R46	Same as A1R23			
A1R47	Same as A1R25			
A1R48	Same as A1R26			
A1R49	Same as A1R19			
A1R50	Resistor, Fixed, Composition, 12K, 5%, ¼W	RC07GF123J	81349	1

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A1R51	Same as A1R4			
A1R52	Same as A1R4			
A1R53	Same as A1R6			
A1R54	Resistor, Fixed, Film, 2.49K, 1%, ¼W	RN60D2491F	81349	3
A1R55	Same as A1R54			
A1R56	Same as A1R54			
A1R57	Same as A1R27			
A1R63	Same as A1R8			
A1R64	Resistor, Fixed, Composition, 10 Ohms, 5%, ¼W	RC07GF100J	81349	1
A1R65	Same as A1R23			
A1R66	Same as A1R39			
A1R68	Same as A1R2			
A1R69	Resistor, Fixed, Composition, 3K, 5%, ¼W	RC07GF302J	81349	2
A1R70	Same as A1R69			
A1R71	Same as A1R23			
A1R72	Same as A1R4			
A1T1	Transformer	163369	82199	1
A1T2	Transformer	163370	82199	1
A1T3	Transformer	163371	82199	1
A1T4	Transformer	163372	82199	1
A1U1	Integrated Circuit	SN74LS04N	01295	1
A1U2	Integrated Circuit	SN75027BN	01295	1
A1U3	Integrated Circuit	SN74LS55N	01295	1
A1U4	Integrated Circuit	741CE	49671	1
A1U5	Integrated Circuit	OP27FZ	31148	1
A1U6	Integrated Circuit	MC10137P	04713	1
A1U7	Integrated Circuit	SN74LS74AN	01295	1
A1U8	Integrated Circuit	SN74LS90N	01295	3
A1U9	Same as A1U8			
A1U10	Same as A1U8			
A1X1	Mixer	SRA-1	15542	1
A1Y1	Crystal	163359	82199	2
A1Y2	Same as A1Y1			

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A2	LOOP NO. 2 DIVIDER BOARD ASSEMBLY (See Fig. 6-4)	163039	82199	1
A2C1	Capacitor, Fixed, Ceramic, 0.1 UF, 100 WVDC	RPE121Z5U104M	72982	8
A2C2	Capacitor, Fixed, Ceramic, 1000 PF	CCD-102	84171	2
A2C3	Capacitor, Fixed, Ceramic, 100 PF	CCD-101	84171	1
A2C4	Same as A2C2			
A2C5	Capacitor, Fixed, Electrolytic, 10 UF, 35 WVDC	VTL10S35	37942	2
A2C6	Same As A2C5			
A2C9	Capacitor, Fixed, Monolithic, 2.2 UF, 50 WVDC	3C37Z5U225M050B	56289	1
A2C10	Same as A2C1			
A2C11	Same as A2C1			
A2C12	Same as A2C1			
A2C13	Same as A2C1			
A2C14	Same as A2C1			
A2C15	Same as A2C1			
A2C17	Capacitor, Fixed, Electrolytic, 1000 UF, 16 WVDC	TDA1000UF16V	61449	1
A2C18	Same as A2C17			
A2L1	Coil, RF	1537-06	71895	7
A2L2	Same as A2L1			
A2L3	Same as A2L1			
A2L4	Same as A2L1			
A2L5	Same as A2L1			
A2L6	Same as A2L1			
A2L7	Same as A2L1			
A2L8	Coil, RF	1537-36	71895	2
A2L9	Same as A2L8			
A2P2	Connector	R115666	C1213	2
A2P4	Same as A2P2			
A2R2	Resistor, Fixed, Composition, 750 Ohms, 5%, ¼W	RC07GF751J	81349	1
A2R3	Resistor, Fixed, Composition, 270 Ohms, 5%, ¼W	RC07GF271J	81349	1
A2R4	Resistor, Fixed, Composition, 82 Ohms, 5%, ¼W	RC07GF820J	81349	1
A2R5	Resistor, Fixed, Composition, 180 Ohms, 5%, ¼W	RC07GF181J	81349	1
A2R6	Resistor, Fixed, Film, 750 Ohms, 1%, 1/8W	RN55D7500F	81349	1
A2R7	Resistor, Fixed, Composition, 56K, 5%, ¼W	RC07GF563J	81349	1
A2U1	Integrated Circuit	SP8647B	14583	1
A2U2	Integrated Circuit	SN74S162N	01295	4
A2U3	Same as A2U2			
A2U4	Same as A2U2			
A2U5	Integrated Circuit	SN74LS374N	01295	3
A2U6	Same as A2U5			
A2U7	Integrated Circuit	SN74S163N	01295	1
A2U8	Integrated Circuit	DM74S283N	36482	1
A2U9	Same as A2U5			
A2U10	Same as A2U2			
A2U11	Integrated Circuit	SN74S85N	01295	1
A2U12	Integrated Circuit	SN74S04N	01295	1
A2U13	Integrated Circuit	SN74LS241N	01295	1
A2U15	Integrated Circuit	SN74LS154N	01295	1
A2U18	Integrated Circuit	SN74S30N	01295	1
A2U19	Integrated Circuit	MC10131P	04713	1

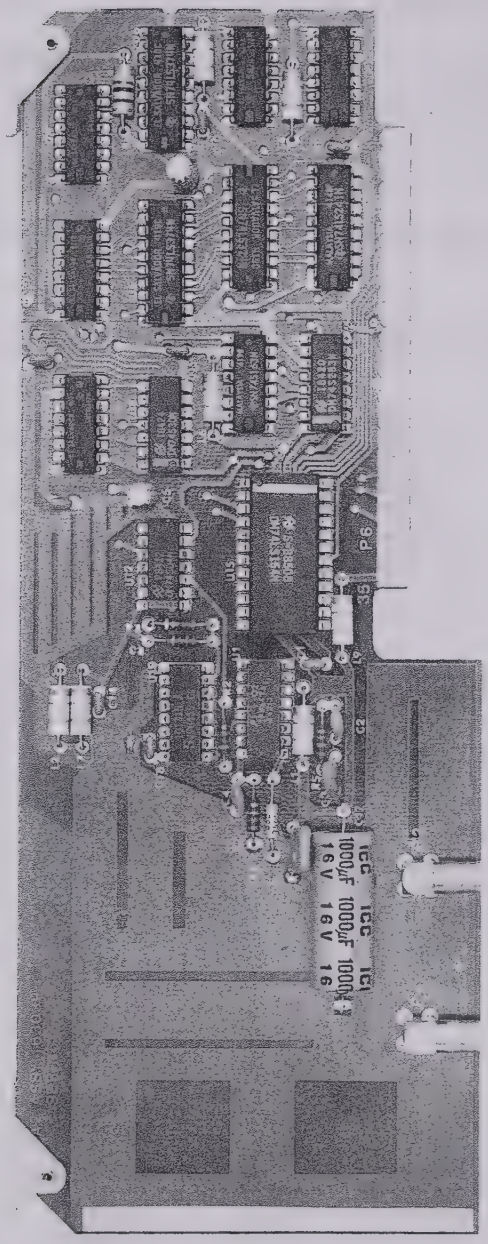

Figure 6-4. Loop No. 2 Divider Board Assembly A2, Parts Location

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A3	**1 KHz LOOP BOARD ASSEMBLY (See Fig. 6-5)**	**163036-2**	**82199**	**1**
A3C1	Capacitor, Fixed, Ceramic, 0.1 UF, 100 WVDC	RPE110X7R103K	72982	2
A3C2	Same as A3C1			
A3C4	Capacitor, Fixed, Electrolytic, 10 UF, 35 WVDC	VTL10S35	37942	11
A3C5	Same as A3C4			
A3C6	Capacitor, Fixed, Ceramic, 0.01 UF, 100 WVDC	RPE110Z5U103M	72982	6
A3C7	Capacitor, Fixed, Ceramic, 0.001 UF, 1000 WVDC	DD-102	71590	9
A3C9	Capacitor, Fixed, Ceramic, 0.1 UF, 100 WVDC	RPE121Z5U104M	72982	8
A3C10	Capacitor, Fixed, Metallic, 2.0 UF, 50 WVDC	MPC-13,2UF	27735	1
A3C11	Same as A3C4			
A3C12	Capacitor, Fixed, Electrolytic, 1000 UF, 16 WVDC	TDA1000UF,16V	61499	1
A3C13	Capacitor, Fixed, Monolithic, 1.5UF, 50 WVDC	2C30Y5U155M050B	56289	1
A3C14	Same as A3C4			
A3C15	Same as A3C7			
A3C17	Same as A3C7			
A3C18	Same as A3C6			
A3C19	Same as A3C7			
A3C20	Same as A3C4			
A3C21	Same as A3C9			
A3C22	Same as A3C4			
A3C23	Same as A3C6			
A3C24	Same as A3C6			
A3C25	Same as A3C6			
A3C26	Capacitor, Fixed, Electrolytic, 470 UF, 16 WVDC	TDB470UF,16V	61499	1
A3C27	Same as A3C4			
A3C28	Same as A3C9			
A3C29	Same as A3C4			
A3C30	Capacitor, Fixed, Mica, 27 PF, 500 WVDC	CM05CD120J03	81349	1
A3C31	Same as A3C4			
A3C32	Same as A3C6			
A3C33	Same as A3C7			
A3C34	Same as A3C7			
A3C35	Same as A3C7			
A3C36	Same as A3C7			
A3C37	Same as A3C9			
A3C38	Same as A3C9			
A3C39	Capacitor, Fixed, Metallic, 0.1 UF	MPC23-.100-50-1	27735	4
A3C40	Same as A3C39			
A3C41	Same as A3C39			
A3C42	Same as A3C7			
A3C43	Same as A3C7			
A3C44	Same as A3C9			
A3C45	Same as A3C9			
A3C46	Same as A3C4			
A3C47	Capacitor, Fixed, Ceramic, 0.047 UF, 100 WVDC	RPE122X7R473K	72982	1
A3C48	Same as A3C4			
A3C49	Capacitor, Fixed, Electrolytic, 4.7 UF, 35 WVDC	VTL4R7S35	37942	2
A3C50	Same as A3C9			
A3C51	Same as A3C39			

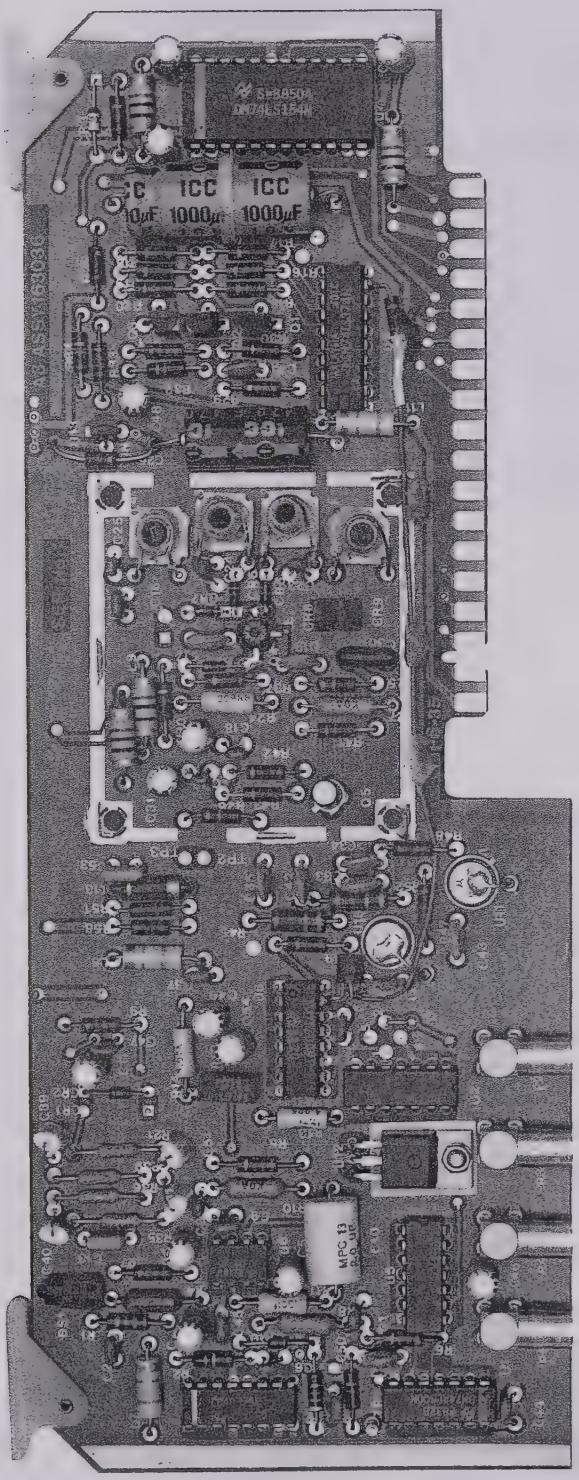

Figure 6-5. 1 kHz Loop Board Assembly A3, Parts Location

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A3C53	Capacitor, Fixed, Ceramic, 0.15 UF, 100 WVDC	2C20X5R154K100B	56289	1
A3C54	Same as A3C49			
A3CR2	Semiconductor Device, Diode	1N456	81349	2
A3CR3	Semiconductor Device, Diode	1N5231B	81349	1
A3CR4	Semiconductor Device, Diode	1N4001	81349	1
A3CR5	Semiconductor Device, Diode	5082-3039	28480	3
A3CR6	Same as A3CR5			
A3CR7	Same as A3CR5			
A3CR8	Semiconductor, Device, Diode	MV-209	04713	2
A3CR9	Same as A3CR8			
A3CR10	Same as A3CR2			
A3DS1	Light Emitting Diode	SRL-035.1350	C1011	1
A3L1	Coil, RF	163231-1	82199	1
A3L2	Coil, RF	163231-2	82199	1
A3L3	Coil, RF	163231-3	82199	1
A3L4	Coil, RF	163231-4	82199	1
A3L6	Coil, RF	1537-36	71895	4
A3L7	Coil, RF	1537-06	71895	3
A3L8	Same as A3L7			
A3L9	Same as A3L6			
A3L10	Same as A3L6			
A3L11	Same as A3L7			
A3L12	Same as A3L6			
A3L13	Coil, RF	1537-737	71895	1
A3P2	Connector	R511666	C1213	4
A3P3	Same as A3P2			
A3P4	Same as A3P2			
A3P5	Same as A3P2			
A3Q1	Transistor	2N4402	81349	3
A3Q2	Same as A3Q1			
A3Q3	Same as A3Q1			
A3Q4	Transistor	BFR91	73445	1
A3Q5	Transistor	2N5179	81349	1
A3Q6	Transistor	2N4006	81349	1
A3R1	Resistor, Fixed, Composition, 680 Ohms, 5%, ¼W	RC07GF681J	81349	1
A3R2	Resistor, Fixed, Composition, 100K, 5%, ¼W	RC07GF104J	81349	1
A3R3	Resistor, Fixed, Composition, 2K, 5%, ¼W	RC07GF202J	81349	1
A3R4	Resistor, Fixed, Film, 49.9 Ohms, 1%, ¼W	RN60D49R9F	81349	1
A3R5	Resistor, Fixed, Composition, 510 Ohms, 5%, ¼W	RC07GF511J	81349	1
A3R6	Same as A3R5			
A3R7	Resistor, Fixed, Composition, 110 Ohms, 5%, ¼W	RC07GF111J	81349	5
A3R8	Resistor, Fixed, Film, 3.57K, 1%, ¼W	RN60D3571F	81349	2
A3R9	Same as A3R7			
A3R10	Same as A3R8			
A3R11	Resistor, Fixed, Film, 1.5K, 1%, ¼W	RN60D1501F	81349	1
A3R12	Resistor, Variable, 1K	RJ24FX102F	81349	1
A3R13	Resistor, Fixed, Film, 4.02K, 1%, ¼W	RN60D4021F	81349	2
A3R14	Same as A3R13			
A3R15	Resistor, Fixed, Composition, 1K, 5%, ¼W	RC07GF102J	81349	10
A3R16	Same as A3R15			

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A3R17	Same as A3R15			
A3R18	Same as A3R15			
A3R19	Same as A3R15			
A3R20	Same as A3R15			
A3R21	Resistor, Fixed, Film, 649 Ohms, 1%, ¼W	RN60D6490F	81349	4
A3R22	Resistor, Fixed, Composition, 10 Ohms, 5%, ¼W	RC07GF100J	81349	1
A3R23	Resistor, Fixed, Composition, 180 Ohms, 5%, ¼W	RC07GF181J	81349	1
A3R24	Resistor, Fixed, Film, 1K, 1%, ¼W	RN60D1001F	81349	2
A3R25	Resistor, Fixed, Composition, 20K, 5%, ¼W	RC07GF203J	81349	2
A3R26	Same as A3R25			
A3R27	Resistor, Fixed, Film, 3.01K, 5%, ¼W	RN60D3011F	81349	1
A3R28	Same as A3R15			
A3R29	Same as A3R7			
A3R30	Resistor, Fixed, Composition, 10K, 5%, ¼W	RC07GF103J	81349	4
A3R31	Same as A3R7			
A3R32	Same as A3R30			
A3R33	Same as A3R7			
A3R34	Same as A3R30			
A3R35	Same as A3R21			
A3R36	Same as A3R21			
A3R37	Same as A3R5			
A3R38	Same as A3R15			
A3R39	Same as A3R21			
A3R40	Same as A3R15			
A3R41	Same as A3R30			
A3R42	Resistor, Fixed, Composition, 5.1K, 5%, ¼W	RC07GF512J	81349	1
A3R43	Resistor, Fixed, Composition, 1.2K, 5%, ¼W	RC07GF122J	81349	1
A3R45	Resistor, Fixed, Composition, 330 Ohms, 5%, ¼W	RC07GF331J	81349	2
A3R47	Resistor, Fixed, Composition, 50 Ohms, 5%, ¼W	RC07GF510J	81349	4
A3R48	Same as A3R47			
A3R49	Same as A3R15			
A3R51	Same as A3R47			
A3R52	Same as A3R45			
A3R53	Same as A3R47			
A3R54	Resistor, Fixed, Composition, 4.7K, 5%, ¼W	RC07GF472J	81349	1
A3TP1	Terminal	229-2084	98921	3
A3TP2	Same as A3TP1			
A3TP3	Same as A3TP1			
A3U1	Integrated Circuit	SN74LS00N	01295	1
A3U2	Integrated Circuit	74F74PC	13715	2
A3U3	Integrated Circuit	SN74LS374N	01295	1
A3U4	Integrated Circuit	MC14027B	04713	1
A3U5	Same as A3U2			
A3U6	Integrated Circuit	OP27FZ	31148	1
A3U7	Integrated Circuit	SN74LS154N	01295	1
A3U8	Integrated Circuit	MC12009P	04713	1
A3U10	Integrated Circuit	MWA120	04713	2
A3U11	Same as A3U10			
A3U12	Integrated Circuit	MC78M05CT	04713	1
A3U13	Integrated Circuit	MC79L12ACP	04713	1

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A4	**LOOP NO. 3A BOARD ASSEMBLY** (See Fig. 6-6)	163027	82199	1
A4C1	Capacitor, Fixed, Electrolytic, 10 UF, 25 WVDC	VTL10S25	37942	8
A4C2	Capacitor, Fixed, Ceramic, 0.001 UF, 1000 WVDC	CCD-102	84171	16
A4C3	Same as A4C1			
A4C4	Same as A4C2			
A4C5	Same as A4C1			
A4C6	Same as A4C2			
A4C7	Capacitor, Fixed, Ceramic, 0.-1 UF, 1000 WVDC	CCD-103	84171	7
A4C8	Same as A4C2			
A4C9	Same as A4C2			
A4C10	Same as A4C7			
A4C11	Same as A4C2			
A4C12	Same as A4C1			
A4C13	Same as A4C2			
A4C14	Same as A4C2			
A4C15	Same as A4C1			
A4C17	Same as A4C2			
A4C18	Same as A4C1			
A4C19	Same as A4C1			
A4C20	Same as A4C2			
A4C21	Same as A4C2			
A4C22	Same as A4C1			
A4C23	Same as A4C1			
A4C24	Capacitor, Fixed, Monolithic, 1.0 UF, 50 WVDC	2C25Z5U105M050B	56289	1
A4C25	Same as A4C2			
A4C26	Same as A4C2			
A4C27	Same as A4C7			
A4C28	Same as A4C7			
A4C29	Same as A4C7			
A4C30	Same as A4C7			
A4C31	Same as A4C2			
A4C32	Same as A4C2			
A4C33	Same as A4C7			
A4C34	Capacitor, Fixed, Ceramic, 120 PF, 1000 WVDC	CCD-121	84171	1
A4CR1	Semiconductor Device, Diode	1N5711	81349	2
A4CR2	Same as A4CR1			
A4CR4	Semiconductor Device, Diode	MV209	04713	4
A4CR5	Same as A4CR4			
A4CR6	Same as A4CR4			
A4CR7	Same as A4CR4			
A4CR8	Semiconductor Device, Diode	1N914	81349	5
A4CR9	Same as A4CR8			
A4CR10	Same as A4CR8			
A4CR11	Same as A4CR8			
A4CR12	Same as A4CR8			
A4DS1	Light Emitting Diode	SRL-035-1350	C1011	1
A4L1	Coil, RF	1537-36	71895	2
A4L2	Same as A4L1			
A4L3	Coil, RF	1537-06	71895	1

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A4L4	Coil, RF	163540	82199	1
A4L5	Coil, RF	1025-60	71895	1
A4P1	Connector	R115666	C1213	2
A4P2	Same as A4P1			
A4Q1	Transistor	2N5179	81349	1
A4Q2	Transistor	BFR91	04713	1
A4Q3	Transistor	2N3906	81349	3
A4Q4	Transistor	2N918	81349	3
A4Q5	Same as A4Q4			
A4Q6	Same as A4Q3			
A4Q7	Same as A4Q3			
A4Q8	Same as A4Q4			
A4Q9	Transistor	2N4400	81349	1
A4R1	Resistor, Fixed, Composition, 470 Ohms, 5%, ¼W	RC07GF471J	81349	6
A4R2	Same as A4R1			
A4R3	Same as A4R1			
A4R4	Same as A4R1			
A4R5	Resistor, Fixed, Composition, 47 Ohms, 5%, ¼W	RC07GF470J	81349	5
A4R6	Resistor, Fixed, Composition, 1K, 5%, ¼W	RC07GF102J	81349	10
A4R7	Resistor, Fixed, Composition, 3.3K, 5%, ¼W	RC07GF332J	81349	1
A4R8	Same as A4R1			
A4R9	Same as A4R6			
A4R10	Resistor, Fixed, Composition, 2.7K, 5%, ¼W	RC07GF272J	81349	1
A4R11	Same as A4R5			
A4R12	Resistor, Fixed, Composition, 5.6K, 5%, ¼W	RC07GF562J	81349	3
A4R13	Resistor, Fixed, Composition, 10K, 5%, ¼W	RC07GF103J	81349	3
A4R14	Resistor, Fixed, Composition, 100 Ohms, 5%, ¼W	RC07GF101J	81349	3
A4R15	Same as A4R6			
A4R16	Resistor, Fixed, Film, 4.75K, 1%, ¼W	RN60D4751F	81349	2
A4R17	Resistor, Fixed, Composition, 220 Ohms, 5%, ¼W	RC07GF221J	81349	2
A4R18	Same as A4R16			
A4R19	Resistor, Fixed, Film, 392 Ohms, 1%, ¼W	RN60D3920F	81349	2
A4R20	Same as A4R17			
A4R21	Resistor, Fixed, Composition, 680 Ohms, 5%, ¼W	RC07GF681J	81349	2
A4R22	Same as A4R19			
A4R23	Same as A4R13			
A4R24	Same as A4R13			
A4R25	Resistor, Fixed, Composition, 5.1K, 5%, ¼W	RC07GF512J	81349	1
A4R26	Resistor, Fixed, Composition, 47K, 5%, ¼W	RC07GF473J	81349	1
A4R27	Same as A4R12			
A4R28	Resistor, Fixed, Composition, 10 Ohms, 5%, ¼W	RC07GF100J	81349	2
A4R30	Resistor, Fixed, Composition, 120 Ohms, 5%, ¼W	RC07GF121J	81349	1
A4R31	Same as A4R5			
A4R32	Same as A4R5			
A4R33	Same as A4R1			
A4R34	Same as A4R6			
A4R35	Resistor, Fixed, Composition,2.2K, 5%, ¼W	RC07GF221J	81349	1
A4R36	Same as A4R12			
A4R37	Same as A4R21			
A4R38	Same as A4R6			

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A4R39	Same as A4R6			
A4R40	Same as A4R6			
A4R41	Resistor, Fixed, Composition, 510 Ohms, 5%, ¼W	RC07GF511J	81349	2
A4R42	Same as A4R41			
A4R43	Same as A4R6			
A4R44	Same as A4R6			
A4R45	Resistor, Fixed, Composition, 390 Ohms, 5%, ¼W	RC07GF391J	81349	1
A4R46	Same as A4R5			
A4R47	Same as A4R14			
A4R48	Same as A4R17			
A4R49	Same as A4R6			
A4R50	Same as A4R28			
A4R51	Same as A4R14			
A4U1	Integrated Circuit	F10109PC	13715	2
A4U2	Integrated Circuit	LM2901N	36482	1
A4U3	Integrated Circuit	SN74LS73AN	01295	1
A4U4	Integrated Circuit	SN74LS00N	01295	1
A4U5	Integrated Circuit	MC10131P	04713	1
A4U6	Same as A4U1			
A4U7	Integrated Circuit	F10137P	13715	2
A4U8	Same as A4U7			
A4U9	Integrated Circuit	F100114DC	13715	2
A4U10	Same as A4U9			
A4U11	Integrated Circuit	SN74LS374N	01295	1
A4U12	Integrated Circuit	SN74LS241N	01295	1
A4U13	Integrated Circuit	SN74LS154N	01295	1
A4XU1	Heatsink	6011B	13103	5
A4XU3	Socket, IC	514AG10D	91506	1
A4XU5	Same as A4XU1			
A4XU6	Same as A4XU1			
A4XU7	Same as A4XU1			
A4XU8	Same as A4XU1			

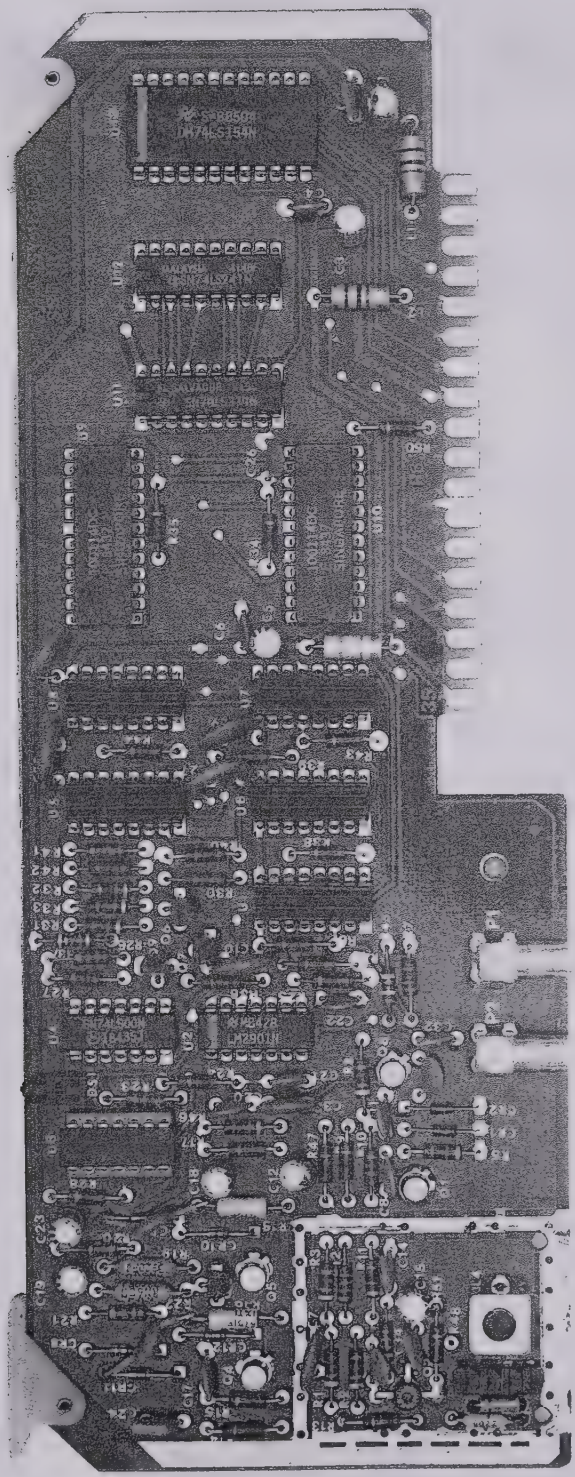

Figure 6-6. Loop No. 3A Board Assembly A4, Parts Location

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A5	**LOOP NO. 3B BOARD ASSEMBLY** (See Fig. 6-7)	**163172**	**82199**	**1**
A5C1	Capacitor, Fixed, Electrolytic, 10 UF, 35 WVDC	VTL10S35	37942	10
A5C2	Capacitor, Fixed, Ceramic, 0.001 UF	8101-100-651-102M	72982	8
A5C3	Same as A5C1			
A5C4	Same as A5C2			
A5C5	Same as A5C1			
A5C6	Capacitor, Fixed, Ceramic, 0.001 UF	CCD-102	84171	13
A5C7	Same as A5C6			
A5C8	Capacitor, Fixed, Ceramic, 0.01 UF, 150 WVDC	DDM-103	71590	6
A5C9	Same as A5C8			
A5C11	Same as A5C1			
A5C12	Capacitor, Fixed, Electrolytic, 10 UF, 35 WVDC	990010-01	82199	1
A5C13	Capacitor, Fixed, Mica, 27 PF	CM04ED270J03	81349	2
A5C14	Same as A5C13			
A5C15	Same as A5C2			
A5C16	Same as A5C6			
A5C17	Capacitor, Fixed, Mica, 68 PF	CM04ED680J03	81349	1
A5C18	Capacitor, Fixed, Ceramic, 22 UF, 100 WVDC	113X7R224K100V	72982	1
A5C19	Same as A5C2			
A5C20	Capacitor, Fixed, Mica, 910 PF	CM05FD911J03	81349	1
A5C21	Capacitor, Fixed, Ceramic, 4700 PF, 100 WVDC	113COG472J100V	72982	1
A5C22	Same as A5C20			
A5C23	Same as A5C1			
A5C24	Same as A5C1			
A5C25	Same as A5C8			
A5C26	Capacitor, Fixed, Ceramic, 10 PF, 500 WVDC	100B100JRW500X	29990	1
A5C27	Same as A5C6			
A5C28	Same as A5C1			
A5C29	Same as A5C6			
A5C30	Capacitor, Fixed, Ceramic, 5.1 PF, 500 WVDC	100B5R1CRW500X	29990	1
A5C31	Capacitor, Fixed, Mica, 2 PF	SCDM10-020D	84171	1
A5C32	Capacitor, Fixed, Ceramic, 15 PF, 500 WVDC	100B150JRW500X	29990	1
A5C33	Same as A5C1			
A5C34	Same as A5C6			
A5C35	Same as A5C6			
A5C36	Same as A5C6			
A5C37	Same as A5C2			
A5C38	Same as A5C2			
A5C39	same as A5C6			
A5C40	Same as A5C2			
A5C41	Same as A5C6			
A5C42	Same as A5C6			
A5C43	Same as A5C2			
A5C44	Same as A5C1			
A5C45	Same as A5C8			
A5C46	Same as A5C1			
A5C47	Same as A5C8			
A5C48	Same as A5C6			
A5C49	Same as A5C8			

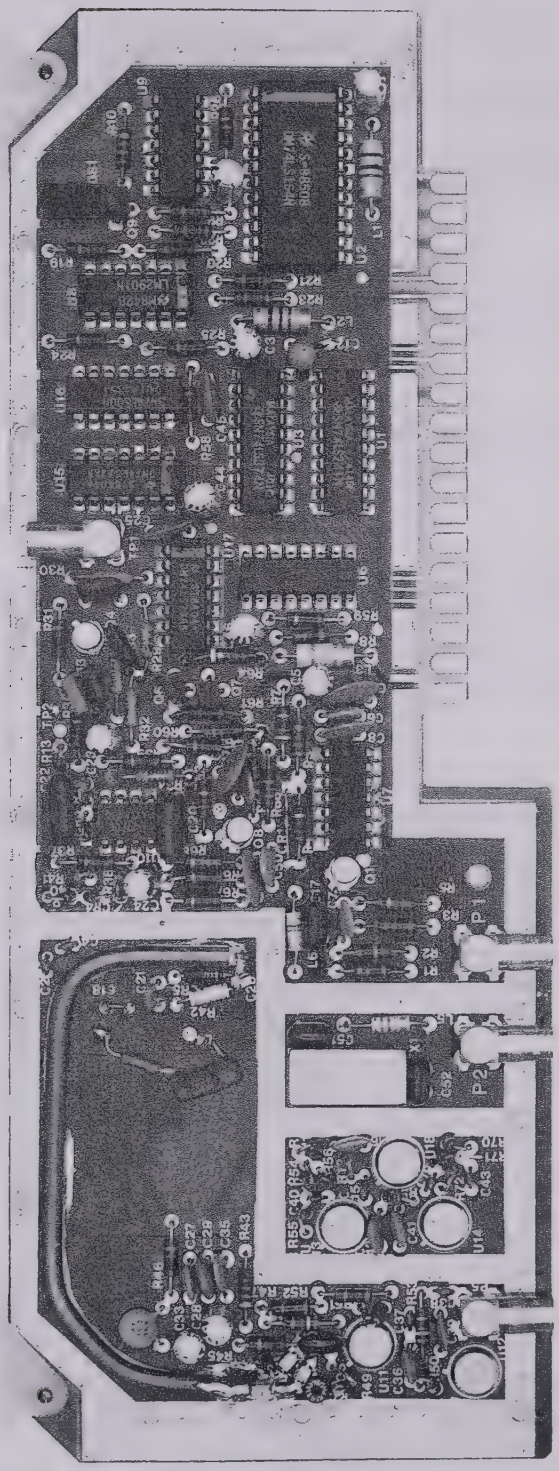

Figure 6-7. Loop No. 3B Board Assembly A5, Parts Location

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A5C50	Same as A5C6			
A5C51	Capacitor, Fixed, Mica, 120 PF	CM04FD121J03	81349	1
A5C52	Same as A5C17			
A5C53	Capacitor, Variable, 0.6-4.5 PF	37270	91293	1
A5C54	Capacitor, Fixed, Ceramic, 8.2 PF, 500 WVDC	100B8R2JNMS500X	29990	1
A5C55	Capacitor, Fixed, Mica, 22 PF	CM04ED220J03	81349	1
A5C56	Capacitor, Fixed, Ceramic, 0.47 UF, 100 WVDC	122X7R473K100V	72982	1
A5C57	Capacitor, Fixed, Ceramic, 10 PF, 100 WVDC	110COG100J100V	72982	1
A5CR1	Semiconductor Device, Diode	1N5711	81349	1
A5CR3	Semiconductor Device, Diode	1N914	81349	2
A5CR4	Same as A5CR3			
A5CR5	Semiconductor Device, Diode	1N5461B	81349	1
A5DS1	Light Emitting Diode	SRL-035.1350	C1011	1
A5L1	Coil, RF	1537-36	71895	2
A5L2	Same as A5L1			
A5L3	Coil, RF	1537-06	71895	1
A5L4	Coil, RF	1025-08	71895	1
A5L5	Coil, RF	1025-04	71895	2
A5L6	Same as A5L5			
A5P1	Connector	R115666	C1213	4
A5P2	Same as A5P1			
A5P5	Same as A5P1			
A5Q1	Transistor	2N918	81349	3
A5Q4	Same as A5Q1			
A5Q5	Transistor	BFR91	04713	1
A5Q6	Transistor	2N3906	81349	2
A5Q7	Same as A5Q6			
A5Q8	Same as A5Q1			
A5Q9	Transistor	2N4400	81349	1
A5R1	Resistor, Fixed, Composition, 300 Ohms, 5%, ¼W	RC07GF301J	81349	2
A5R2	Resistor, Fixed, Composition, 18 Ohms, 5%, ¼W	RC07GF180J	81349	1
A5R3	Same as A5R1			
A5R4	Resistor, Fixed, Composition, 2.2K, 5%, ¼W	RC07GF222J	81349	2
A5R5	Resistor, Fixed, Composition, 2.7K, 5%, ¼W	RC07GF272J	81349	3
A5R6	Resistor, Fixed, Composition, 560 Ohms, 5%, ¼W	RC07GF561J	81349	1
A5R7	Resistor, Fixed, Composition, 47 Ohms, 5%, ¼W	RC07GF470J	81349	1
A5R8	Resistor, Fixed, Composition, 3 Ohms, 5%, ¼W	RC07GF3R0J	81349	1
A5R9	Resistor, Fixed, Composition, 5.6K, 5%, ¼W	RC07GF562J	81349	4
A5R10	Resistor, Fixed, Composition, 680 Ohms, 5%, ¼W	RC07GF681J	81349	1
A5R11	Resistor, Fixed, Composition, 82 Ohms, 5%, ¼W	RC07GF820J	81349	7
A5R12	Resistor, Fixed, Composition, 390 Ohms, 5%, ¼W	RC07GF391J	81349	5
A5R13	Resistor, Fixed, Composition, 10K, 5%, ¼W	RC07GF103J	81349	2
A5R19	Resistor, Fixed, Composition, 12K, 5%, ¼W	RC07GF123J	81349	2
A5R20	Resistor, Fixed, Composition, 1K, 5%, ¼W	RC07GF102J	81349	6
A5R21	Same as A5R9			
A5R22	Same as A5R9			
A5R23	Same as A5R9			
A5R24	Resistor, Fixed, Composition, 2K, 5%, ¼W	RC07GF202J	81349	2
A5R25	Same as A5R19			
A5R26	Same as A5R13			

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A5R29	Resistor, Fixed, Film, 604 Ohmd, 1%, 1/8W	RN55D6040F	81349	2
A5R30	Same as A5R29			
A5R31	Same as A5R20			
A5R32	Resistor, Fixed, Film, 3.48K, 1%, 1/8W	RN55D3481F	81349	2
A5R33	Same as A5R32			
A5R34	Resistor, Fixed, Film, 10K, 1%, 1/8W	RN55D1002F	81349	2
A5R35	Same as A5R34			
A5R36	Same as A5R4			
A5R37	Resistor, Fixed, Composition, 100 Ohms, 5%, ¼W	RC07GF101J	81349	6
A5R38	Resistor, Fixed, Film, 499 Ohms, 1%, 1/8W	RN55D4990F	81349	1
A5R39	Same as A5R37			
A5R40	Resistor, Fixed, Composition, 910 Ohms, 5%, ¼W	RC07GF911J	81349	1
A5R41	Same as A5R37			
A5R42	Resistor, Fixed, Film, 56.2 Ohms, 1%, 1/8W	RN55D56R2F	81349	1
A5R43	Resistor, Fixed, Composition, 470 Ohms, 5%, ¼W	RC07GF471J	81349	2
A5R44	Resistor, Fixed, Composition, 1.8K, 5%, ¼W	RC07GF182J	81349	1
A5R45	Same as A5R24			
A5R46	Same as A5R20			
A5R47	Same as A5R11			
A5R48	Same as A5R12			
A5R49	Same as A5R37			
A5R50	Same as A5R37			
A5R51	Same as A5R37			
A5R52	Same as A5R11			
A5R53	Same as A5R12			
A5R54	Same as A5R11			
A5R55	Same as A5R12			
A5R56	Same as A5R11			
A5R57	Same as A5R12			
A5R58	Resistor, Fixed, Composition, 10 Ohms, 5%, ¼W	RC07GF100J	81349	2
A5R59	Same as A5R58			
A5R60	Same as A5R20			
A5R61	Resistor, Fixed, Composition, 51 Ohms, 5%, ¼W	RC07GF510J	81349	1
A5R62	Same as A5R20			
A5R63	Same as A5R5			
A5R64	Resistor, Fixed, Composition, 160 Ohms, 5%, ¼W	RC07GF161J	81349	1
A5R65	Same as A5R43			
A5R66	Same as A5R5			
A5R67	Resistor, Fixed, Composition, 22 Ohms, 5%, ¼W	RC07GF220J	81349	1
A5R68	Resistor, Fixed, Composition, 220 Ohms, 5%, ¼W	RC07GF221J	81349	1
A5R69	Same as A5R20			
A5R70	Same as A5R11			
A5R71	Resistor, Fixed, Composition, 91 Ohms, 5%, ¼W	RC07GF910J	81349	1
A5R72	Same as A5R11			
A5R73	Resistor, Fixed, Composition, 33 Ohms, 5%, 1/8W	RC05GF330J	81349	1
A5TP1	Same as A5P1			
A5TP2	Terminal	229-2084	98921	1
A5U1	Integrated Circuit	SN74LS241N	01295	1
A5U2	Integrated Circuit	SN74LS154N	01295	1
A5U3	Integrated Circuit	SN74LS374N	01295	1

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A5U6	Integrated Circuit	SN74LS162N	01295	1
A5U7	Integrated Circuit	74F74PC	13715	1
A5U8	Integrated Circuit	LM2901N	36482	1
A5U9	Integrated Circuit	DM74121N	36482	1
A5U10	Integrated Circuit	OP27FZ	31148	1
A5U11	Integrated Circuit	MWA 220	04713	5
A5U12	Same as A5U11			
A5U13	Same as A5U11			
A5U14	Same as A5U11			
A5U15	Integrated Circuit	SN74LS73AN	01295	2
A5U16	Integrated Circuit	SN74LS00N	01295	1
A5U17	Same as A5U15			
A5U18	Same as A5U11			
A5W1	Coaxial Cable	163360	82199	1
A5X1	Mixer	SBL-1	15542	1

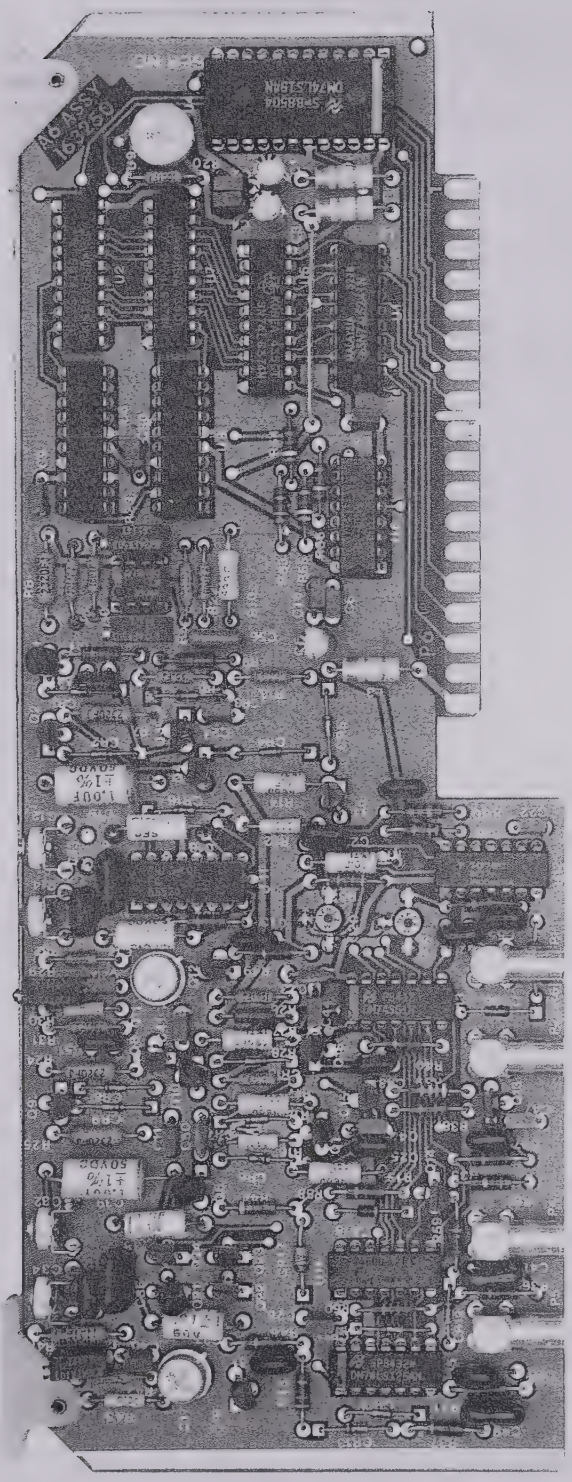

Figure 6-8. Pulse Modulation Board Assembly A6, Parts Location

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A6	**PULSE MODULATION BOARD ASSEMBLY (See Fig. 6-8)**	**163250**	**82199**	1
A6C1	Capacitor, Fixed, Electrolytic, 10 UF, 35 WVDC	VTL10S35	37942	3
A6C2	Capacitor, Fixed, Ceramic, , 0.5 UF, 50 WVDC	CK05BX104K	81349	17
A6C3	Same as A6C1			
A6C4	Same as A6C2			
A6C5	Same as A6C1			
A6C6	Same as A6C2			
A6C7	Same as A6C2			
A6C9	Same as A6C2			
A6C10	Same as A6C2			
A6C11	Same as A6C2			
A6C12	Capacitor, Variable, 5.0–50 PF	GKR50000	56289	4
A6C13	Capacitor, Fixed, Mica, 20 PF, 500 WVDC	CM04ED200J03	81349	3
A6C14	Same as A6C12			
A6C15	Capacitor, Fixed, Mica, 150 PF, 500 WVDC	CM04FD151J03	81349	2
A6C16	Capacitor, Fixed, Mica, 750 PF, 500 WVDC	CM05FD751J03	81349	2
A6C17	Capacitor, Fixed, Metallized Poly, 0.01 UF, 1%, 50 WVDC	900038-01	82199	2
A6C18	Capacitor, Fixed, Metallized Poly, 0.1 UF, 1%, 50 WVDC	900038-12	82199	2
A6C19	Capacitor, Fixed, Metallized Poly, 1.0 UF, 1%, 50 WVDC	900038-24	82199	2
A6C20	Same as A6C2			
A6C21	Capacitor, Fixed, Mica, 62 PF	CM04ED620J03	81349	2
A6C22	Same as A6C2			
A6C23	Capacitor, Fixed, Ceramic, 0.001 UF, 100 WVDC	DD102	71590	2
A6C24	Same as A6C2			
A6C25	Same as A6C21			
A6C26	Capacitor, Fixed, Mica, 100 PF, 500 WVDC	CM04FD101J03	81349	4
A6C27	Same as A6C26			
A6C28	Same as A6C2			
A6C30	Same as A6C2			
A6C31	Same as A6C26			
A6C32	Same as A6C14			
A6C34	Same as A6C14			
A6C35	Same as A6C15			
A6C36	Same as A6C16			
A6C37	Same as A6C17			
A6C38	Same as A6C18			
A6C39	Same as A6C19			
A6C40	Same as A6C2			
A6C41	Same as A6C2			
A6C42	Same as A6C2			
A6C43	Capacitor, Fixed, Mica, 56 PF	CM04ED560J03	81349	1
A6C44	Same as A6C2			
A6C45	Capacitor, Fixed, Mica, 15 PF	CM04CD150J03	81349	2
A6C46	Same as A6C45			
A6C47	Same as A6C2			
A6C48	Capacitor, Fixed, Mica, 150 PF	CM05FC561J03	81349	2

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A6C49	Same as A6C48			
A6C50	Same as A6C23			
A6C51	Same as A6C13			
A6C54	Same as A6C13			
A6C55	Same as A6C26			
A6C56	Capacitor, Fixed, Ceramic, 2.2 UF, 50 WVDC	RPE114Z5U225M-50V	72982	1
A6CR1	Semiconductor Device, Diode	1N4148	81349	15
A6CR2	Same as A6CR1			
A6CR3	Same as A6CR1			
A6CR4	Same as A6CR1			
A6CR5	Same as A6CR1			
A6CR6	Same as A6CR1			
A6CR7	Same as A6CR1			
A6CR8	Same as A6CR1			
A6CR9	Same as A6CR1			
A6CR10	Same as A6CR1			
A6CR11	Same as A6CR1			
A6CR12	Same as A6CR1			
A6CR13	Same as A6CR1			
A6CR14	Same as A6CR1			
A6CR15	Semiconductor Device, Diode	1N456	81349	1
A6CR16	Same as A6CR1			
A6CR17	Semiconductor Device, Diode	1N4739A	81349	1
A6CR18	Semiconductor Device, Diode	1N5711	81349	1
A6L1	Coil, RF	1537-06	71895	3
A6L2	Same as A6L1			
A6L3	Same as A6L1			
A6P1	Connector	R115666	C1213	4
A6P2	Same as A6P1			
A6P4	Same as A6P1			
A6P5	Same as A6P1			
A6Q1	Transistor	2N3563	81349	4
A6Q2	Same as A6Q1			
A6Q3	Transistor	2N4400	81349	4
A6Q4	Transistor	2N2369A	81349	6
A6Q5	Same as A6Q3			
A6Q6	Same as A6Q4			
A6Q7	Same as A6Q3			
A6Q8	Same as A6Q1			
A6Q9	Same as A6Q1			
A6Q10	Same as A6Q3			
A6Q11	Transistor	2N4015	81349	2
A6Q12	Same as A6Q4			
A6Q13	Transistor	MPS4257	04713	2
A6Q14	Same as A6Q4			
A6Q15	Same as A6Q4			
A6Q16	Same as A6Q13			
A6Q17	Same as A6Q11			
A6Q18	Transistor	BFR91	04713	2
A6Q19	Same as A6Q4			

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A6Q20	Same as A6Q18			
A6Q21	Transistor	2N4400	13715	4
A6Q22	Same as A6Q21			
A6Q23	Same as A6Q21			
A6Q24	Same as A6Q21			
A6R3	Resistor, Fixed, Film, 3.01K, 1%, 1/8W	RN55D3011F	81349	2
A6R4	Resistor, Fixed, Film, 1.0K,1%, 1/8W	RN55D1001F	81349	3
A6R5	Resistor, Variable, 50K	RJ24FX503H	81349	2
A6R6	Resistor, Fixed, Film, 232 Ohms, 1%, ¼W	RN60D2320F	81349	4
A6R7	Same as A6R6			
A6R8	Resistor, Fixed, Film, 1.58K, 1%, 1/8W	RN55D1581F	81349	2
A6R9	Resistor, Fixed, Film, 4.02K, 1%, 1/8W	RN55D4021F	81349	2
A6R10	Resistor, Fixed, Film, 499 Ohms, 1%, ¼W	RN60D4990F	81349	2
A6R11	Resistor, Fixed, Film, 1.0K, 1%, ¼W	RN60D1001F	81349	4
A6R12	Resistor, Fixed, Film, 3.40K, 1%, 1/8W	RN55D3401F	81349	2
A6R13	Resistor, Fixed, Film, 10.0K, 1%, 1/8W	RN55D1002F	81349	2
A6R14	Same as A6R11			
A6R15	Same as A6R11			
A6R16	Same as A6R12			
A6R17	Same as A6R13			
A6R18	Same as A6R11			
A6R20	Same as A6R4			
A6R21	Same as A6R3			
A6R22	Same as A6R4			
A6R23	Same as A6R5			
A6R24	Same as A6R6			
A6R25	Same as A6R6			
A6R26	Same as A6R8			
A6R27	Same as A6R9			
A6R28	Same as A6R10			
A6R29	Resistor, Variable, 500 Ohms	RJ24FX501F	81349	1
A6R30	Resistor, Fixed, Film, 2.80K, 1%, 1/8W	RN55D2801F	81349	1
A6R31	Resistor, Fixed, Film, 3.01K, 1%, 1/8W	RN55D3011F	81349	1
A6R32	Resistor, Fixed, Film, 11.3K, 1%, 1/8W	RN55D1132F	81349	1
A6R33	Resistor, Fixed, Composition, 470 Ohms, 5%,¼W	RC07GF471J	81349	3
A6R34	Resistor, Fixed, Composition, 1K, 5%, ¼W	RC07GF102J	81349	5
A6R35	Same as A6R34			
A6R36	Resistor, Fixed, Composition, 100 Ohms, 5%, ¼W	RC07GF101J	81349	2
A6R37	Same as A6R36			
A6R38	Resistor, Fixed, Composition, 270 Ohms, 5%, ¼W	RC07GF271J	81349	3
A6R39	Same as A6R33			
A6R40	Resistor, Fixed, Composition, 22 Ohms, 5%, ¼W	RC07GF220J	81349	1
A6R41	Resistor, Variable, 100 Ohms	RJ24FX101J	81349	1
A6R42	Resistor, Fixed, Film, 255 Ohms, 1%, 1/8W	RN55D2550F	81349	1
A6R43	Resistor, Fixed, Film, 301 Ohms, 1%, 1/8W	RN55D3010F	81349	1
A6R44	Resistor, Fixed, Composition, 160 Ohms, 5%, ¼W	RC07GF161J	81349	1
A6R45	Same as A6R33			
A6R46	Resistor, Fixed, Composition, 2.2K, 5%, ¼W	RC07GF222J	81349	1
A6R47	Resistor, Fixed, Film, 1.13K, 1%, ¼W	RN60D1131F	81349	1
A6R49	Same as A6R34			

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A6R50	Resistor, Fixed, Composition, 2.7K, 5%, ¼W	RC07GF272J	81349	2
A6R51	Same as A6R50			
A6R52	Same as A6R38			
A6R53	Resistor, Fixed, Composition, 390 Ohms, 5%, ¼W	RC07GF391J	81349	4
A6R54	Same as A6R53			
A6R55	Same as A6R53			
A6R56	Same as A6R53			
A6R57	Same as A6R38			
A6R58	Same as A6R34			
A6R59	Same as A6R34			
A6R60	Resistor, Fixed, Composition, 5.6K, 5%, ¼W	RC07GF562J	81349	1
A6R61	Resistor, Fixed, Composition, 1.5K, 5%, ¼W	RC07GF152J	81349	1
A6R62	Resistor, Fixed, Composition, 680 Ohms, 5%, ¼W	RC07GF681J	81349	1
A6R63	Resistor, Fixed, Composition, 4.7K, 5%, ¼W	RC07GF472J	81349	1
A6U1	Integrated Circuit	SN74LS241N	01295	1
A6U2	Integrated Circuit	SN74LS374N	01295	3
A6U3	Integrated Circuit	AD7548JN	24355	2
A6U4	Integrated Circuit	SN74LS154N	01295	1
A6U5	Same as A6U2			
A6U6	Integrated Circuit	SN74LS175N	01295	1
A6U7	Same as A6U2			
A6U8	Same as A6U3			
A6U9	Integrated Circuit	LM399H	36482	1
A6U10	Integrated Circuit	LM2904N	36482	1
A6U11	Integrated Circuit	SW-01FQ	31148	1
A6U12	Integrated Circuit	74F74PC	13715	1
A6U13	Integrated Circuit	DM74S51N	36482	1
A6U14	Integrated Circuit	74F00PC	13715	1
A6U15	Integrated Circuit	SN74LS125AN	01295	1

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A7	AM/FM MODULATION BOARD ASSEMBLY (See Fig. 6-9)	163152	82199	1
A7C1	Capacitor. Fixed, Electrolytic, 10 UF, 35 WVDC	VTL-10S35	37942	8
A7C2	Capacitor, Fixed, Electrolytic, 47 UF, 25 WVDC	VTL-47S25	37942	3
A7C3	Same as A7C1			
A7C4	Capacitor, Fixed, Ceramic, 0.001UF, 100 WVDC	RPE121COG102J	72982	7
A7C5	Capacitor, Fixed, Ceramic, 0.01 UF, 100 WVDC	RPE110-X7R-103K	72982	7
A7C6	Same as A7C4			
A7C7	Capacitor, Fixed, Mica, 150 PF, 500 WVDC	CM04FD151J03	81349	5
A7C8	Capacitor, Fixed, Mica, 36 PF, 500 WVDC	CM04ED360J03	81349	1
A7C9	Same as A7C2			
A7C10	Capacitor, Fixed, Ceramic, 0.1UF, 100 WVDC	RPE121-X7RK104	72982	2
A7C11	Same as A7C2			
A7C12	Same as A7C4			
A7C13	Same as A7C7			
A7C14	Capacitor, Fixed, Mica, 27 PF, 500 WVDC	CM04ED270J03	81349	2
A7C15	Capacitor, Fixed, Plastic, 0.033 UF, 100 WVDC	MPC13-.033-50-1	27735	1
A7C16	Same as A7C10			
A7C17	Capacitor, Fixed, Electrolytic, 120 UF, 50 WVDC	109D127X9050F2	56289	1
A7C18	Capacitor, Fixed, Plastic, 0.47 UF, 50 WVDC	MPC13-.47-50-1	27735	2
A7C19	Same as A7C18			
A7C20	Capacitor, Variable, 5.0-50 PF, 125 WVDC	GKR50000	56289	1
A7C21	Capacitor, Fixed, Mica, 180 PF, 500 WVDC	CM04FD181J03	81349	1
A7C22	Capacitor, Fixed, Electrolytic, 10 UF, 20 WVDC	199D106X0020CA1	56289	1
A7C23	Same as A7C4			
A7C24	Capacitor, Fixed, Mica, 10 PF, 500 WVDC	CM04CD100D03	81349	5
A7C25	Same as A7C7			
A7C26	Same as A7C5			
A7C27	Capacitor, Fixed, Ceramic, 0.022 UF, 100 WVDC	RPE110-X7R-223K	72982	1
A7C28	Same as A7C5			
A7C29	Same as A7C7			
A7C30	Same as A7C24			
A7C31	Same as A7C1			
A7C32	Capacitor, Fixed, Ceramic, 330 PF, 500 WVDC	CM05FD331J03	81349	1
A7C33	Same as A7C24			
A7C34	Same as A7C1			
A7C35	Same as A7C5			
A7C36	Same as A7C24			
A7C37	Same as A7C14			
A7C38	Same as A7C7			
A7C39	Same as A7C4			
A7C40	Same as A7C4			
A7C41	Same as A7C5			
A7C42	Same as A7C5			
A7C43	Same as A7C4			
A7C44	Same as A7C5			
A7C45	Same as A7C1			
A7C46	Same as A7C1			
A7C47	Same as A7C1			
A7C48	Same as A7C1			
A7C49	Same as A7C24			

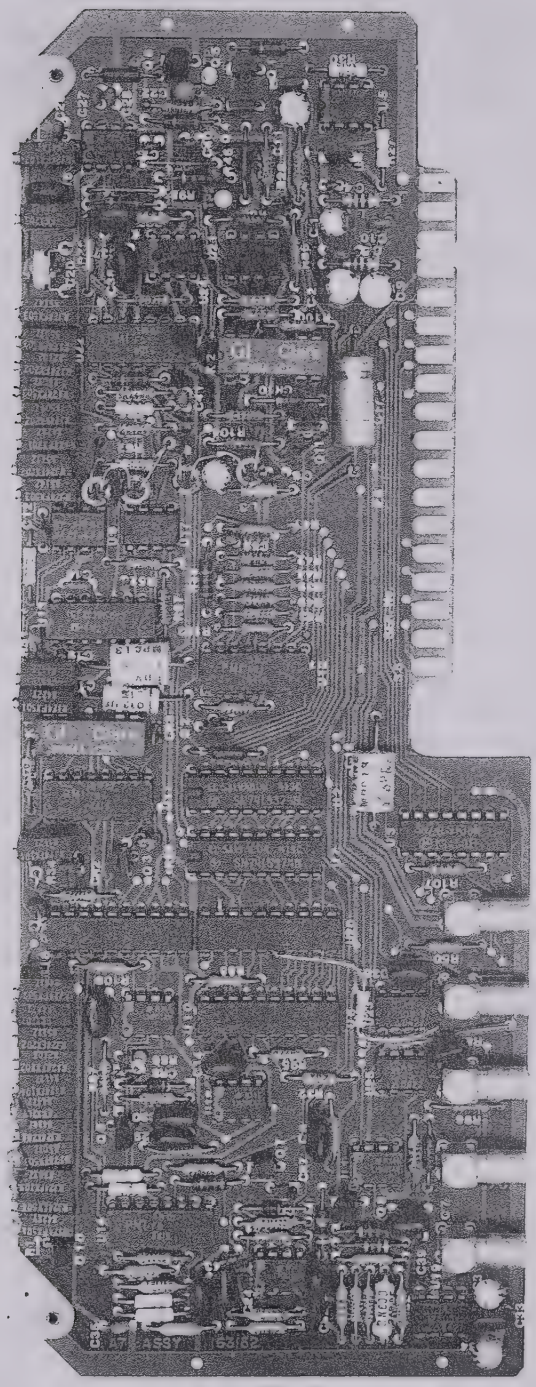

Figure 6-9. AM/FM Modulation Board Assembly A7, Parts Location

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A7CR1	Semiconductor Device, Diode	1N4001	81349	3
A7CR2	Semiconductor Device, Diode	LM385Z	36482	1
A7CR3	Same as A7CR1			
A7CR4	Semiconductor Device, Diode	1N914	81349	2
A7CR5	Same as A7CR4			
A7CR6	Semiconductor Device, Diode	1N459	81349	5
A7CR7	Same as A7CR6			
A7CR8	Same as A7CR6			
A7CR9	Same as A7CR6			
A7CR10	Same as A7CR1			
A7CR11	Same as A7CR6			
A7K1	Relay	PRMA1C05	04761	2
A7K2	Same as A7K1			
A7L1	Coil, RF	1025-44	71895	2
A7L2	Same as A7L1			
A7L3	Coil, RF	1025-12	71895	1
A7P1	Connector	R115666	C1213	5
A7P2	Same as A7P1			
A7P3	Same as A7P1			
A7P4	Same as A7P1			
A7P5	Same as A7P1			
A7Q1	Transistor	2N3906	81349	3
A7Q2	Transistor	2N4400	81349	1
A7Q3	Transistor	2N3904	81349	7
A7Q4	Same as A7Q3			
A7Q5	Same as A7Q1			
A7Q6	Same as A7Q3			
A7Q7	Same as A7Q3			
A7Q8	Same as A7Q1			
A7Q9	Same as A7Q3			
A7Q10	Same as A7Q3			
A7Q11	Same as A7Q3			
A7R1	Resistor, Variable,500 Ohms, 10%, ½W	RJ24FX501F	81349	2
A7R2	Resistor, Variable, 500K, 10%, ½W	RJ24FX504F	81349	1
A7R3	Resistor, Variable, 1M, 10%, ½W	RJ24FX105F	81349	1
A7R4	Resistor, Variable, 50K, 10%, ½W	RJ24FX503F	81349	5
A7R5	Resistor, Variable, 200K, 10%, ½W	RJ24FX204F	81349	1
A7R6	Resistor, Variable, 20K, 10%, ½W	RJ24FX203F	81349	4
A7R7	Resistor, Variable, 100K, 10%, ½W	RJ24FX104F	81349	2
A7R8	Resistor, Variable, 2K, 10%, ½W	RJ24FX202F	81349	5
A7R9	Same as A7R8			
A7R10	Resistor, Variable, 5K, 10%, ½W	RJ24FX502F	81349	1
A7R11	Same as A7R7			
A7R12	Same as A7R1			
A7R13	Same as A7R6			
A7R14	Same as A7R4			
A7R15	Same as A7R8			
A7R16	Resistor, Variable, 200 Ohms, 10%, ½W	RJ24FX201F	81349	1
A7R17	Same as A7R8			
A7R18	Same as A7R4			

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A7R19	Same as A7R8			
A7R20	Same as A7R4			
A7R21	Same as A7R4			
A7R22	Same as A7R6			
A7R23	Resistor, Variable, 10K, 10%, ½W	RJ24FX103F	81349	1
A7R24	Resistor, Fixed, Film, 1.5K, 1%, 1/8W	RN55D1501F	81349	2
A7R25	Resistor, Fixed, Film, 1K, 1%, 1/8W	RN55D1001F	81349	2
A7R26	Resistor, Fixed, Composition, 47 Ohms, 5%, ¼W	RC07GF470J	81349	1
A7R27	Resistor, Fixed, Film, 30.1K, 1%, 1/8W	RN55D3012F	81349	3
A7R28	Resistor, Fixed, Film, 15K, 1%, 1/8W	RN55D1502F	81349	2
A7R29	Resistor, Fixed, Film, 10K, 1%, 1/8W	RN55D1002F	81349	17
A7R30	Same as A7R27			
A7R31	Resistor, Fixed, Film, 100K, 1%, 1/8W	RN55D1003F	81349	3
A7R32	Same as A7R29			
A7R33	Resistor, Fixed, Film, 63.4K, 1%, 1/8W	RN55D6342F	81349	1
A7R34	Resistor, Fixed, Film, 4.99K, 1%, 1/8W	RN55D4991F	81349	3
A7R35	Same as A7R25			
A7R36	Resistor, Fixed, Film, 49.9K, 1%, 1/8W	RN55D4992F	81349	1
A7R37	Same as A7R29			
A7R38	Resistor, Fixed, Composition, 5.1K, 5%, ¼W	RC07GF512J	81349	3
A7R39	Same as A7R29			
A7R40	Resistor, Fixed, Film, 82.5K, 1%, 1/8W	RN55D8252F	81349	1
A7R41	Resistor, Fixed, Film, 604 Ohms, 1%, 1/8W	RN55D6040F	81349	3
A7R42	Same as A7R41			
A7R43	Resistor, Fixed, Film, 3.83K, 1%, 1/8W	RN55D3831F	81349	2
A7R44	Same as A7R43			
A7R45	Resistor, Fixed, Film, 619 Ohms, 1%, 1/8W	RN55D6190F	81349	1
A7R46	Resistor, Fixed, Film, 412 Ohms, 1%, 1/8W	RN55D4120F	81349	1
A7R47	Resistor, Fixed, Composition, 51K, 5%, ¼W	RC07GF513J	81349	3
A7R48	Same as A7R38			
A7R49	Resistor, Fixed, Film, 1.82K, 1%, 1/8W	RN55D1821F	81349	4
A7R50	Same as A7R49			
A7R51	Same as A7R34			
A7R52	Same as A7R29			
A7R53	Resistor, Fixed, Film, 499 Ohms, 1%, 1/8W	RN55D4990F	81349	3
A7R54	Resistor, Fixed, Composition, 560 Ohms, ¼W	RC07GF561J	81349	1
A7R55	Same as A7R27			
A7R56	Resistor, Fixed, Film, 124K, 1%, 1/8W	RN55D1243F	81349	1
A7R57	Resistor, Fixed, Film, 9.31K, 1%, 1/8W	RN55D9311F	81349	2
A7R58	Resistor, Fixed, Film, 26.1K, 1%, 1/8W	RN55D2612F	81349	1
A7R59	Resistor' Fixed, Film, 301K, 1%, 1/8W	RN55D3013F	81349	1
A7R60	Resistor, Fixed, Film, 499K, 1%, 1/8W	RN55D4993F	81349	1
A7R61	Same as A7R29			
A7R62	Resistor, Fixed, Film, 2.21K, 1%, 1/8W	RN55D2211F	81349	3
A7R63	Same as A7R29			
A7R64	Same as A7R38			
A7R65	Same as A7R24			
A7R66	Resistor, Fixed, Film, 5.36K, 1%, 1/8W	RN55D5361F	81349	2
A7R67	Same as A7R66			
A7R68	Same as A7R57			

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A7R69	Same as A7R31			
A7R70	Same as A7R31			
A7R71	Resistor, Fixed, Film, 7.50K, 1%, 1/8W	RN55D7501F	81349	2
A7R72	Same as A7R29			
A7R73	Same as A7R47			
A7R74	Resistor, Fixed, Composition, 4.7K, 5%, ¼W	RC07GF472J	81349	1
A7R75	Resistor, Fixed, Film, 412K, 1%, 1/8W	RN55D4123F	81349	1
A7R76	Resistor, Fixed, Film, 18.2K, 1%, 1/8W	RN55D1822F	81349	1
A7R77	Same as A7R28			
A7R78	Same as A7R29			
A7R79	Resistor, Fixed, Film, 3.16K, 1%, 1/8W	RN55D3161F	81349	1
A7R80	Same as A7R29			
A7R81	Same as A7R29			
A7R82	Resistor, Fixed, Film, 3.01K, 1%, 1/8W	RN55D3011F	81349	1
A7R83	Same as A7R29			
A7R84	Resistor, Fixed, Film, 13K, 1%, 1/8W	RN55D1302F	81349	1
A7R85	Resistor, Fixed, Film, 5.9K, 1%, 1/8W	RN55D5901F	81349	1
A7R86	Same as A7R53			
A7R87	Same as A7R71			
A7R88	Same as A7R51			
A7R89	Same as A7R41			
A7R90	Same as A7R49			
A7R91	Resistor, Fixed, Film, 2.74K, 1%, 1/8W	RN55D2741F	81349	1
A7R92	Resistor, Fixed, Film, 6.19K, 1%, 1/8W	RN55D6191F	81349	1
A7R93	Same as A7R62			
A7R94	Resistor, Fixed, Film, 34.8 Ohms, 1%, 1/8W	RN55D34R8F	81349	1
A7R95	Same as A7R29			
A7R96	Same as A7R29			
A7R97	Same as A7R29			
A7R98	Same as A7R47			
A7R99	Same as A7R49			
A7R100	Same as A7R53			
A7R101	Resistor, Fixed, Composition, 1.2K, 5%, ¼W	RC07GF122J	81349	1
A7R102	Same as A7R62			
A7R103	Resistor, Fixed, Film, 1M, 1%, 1/8W	RN55D1004F	81349	1
A7R104	Resistor, Fixed, Film, 2.37K, 1%, 1/8W	RN55D2371F	81349	1
A7R105	Resistor, Fixed, Film, 787 Ohms, 1%, 1/8W	RN55D7870F	81349	1
A7R106	Same as A7R29			
A7R107	Same as A7R29			
A7R108	Same as A7R6			
A7TP1	Terminal	229-2084	98921	2
A7TP2	Same as A7TP1			
A7U1	Integrated Circuit	LM201AN	36482	5
A7U2	Integrated Circuit	SN74LS374N	01295	2
A7U3	Integrated Circuit	SN74LS138N	01295	1
A7U4	Integrated Circuit	MC78L08ACP	04713	1
A7U5	Integrated Circuit	741CE	49671	1
A7U6	Integrated Circuit	AD7548JN	24355	3
A7U7	Same as A7U2			
A7U8	Same as A7U6			

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A7U9	Integrated Circuit	OP27FZ	31148	2
A7U10	Same as A7U1			
A7U11	Integrated Circuit	SW-01FQ	31148	4
A7U12	Same as A7U11			
A7U13	Integrated Circuit	ICL8038BCJD	U2024	1
A7U14	Same as A7U11			
A7U15	Same as A7U1			
A7U16	Integrated Circuit	LM555CN	36482	1
A7U17	Integrated Circuit	HA7-5101-5	24355	4
A7U18	Same as A7U1			
A7U19	Same as A7U17			
A7U20	Same as A7U6			
A7U21	Same as A7U9			
A7U22	Same as A7U11			
A7U23	Same as A7U17			
A7U24	Same as A7U1			
A7U25	Same as A7U17			

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A8	**POWER SUPPLY BOARD ASSEMBLY**	**163251**	**82199**	**1**
A8A1	Power Supply Board Assembly	163188	82199	1
A8A2	Power Supply Board Assembly	163189	82199	1
A8B1	Fan	FBP-08B12H	S5175	1
A8C1	Capacitor, Feedthru	321-010-X5UO-102	72982	14
A8C2	Same as A8C1			
A8C3	Same as A8C1			
A8C4	Same as A8C1			
A8C5	Same as A8C1			
A8C6	Same as A8C1			
A8C7	Same as A8C1			
A8C8	Same as A8C1			
A8C9	Same as A8C1			
A8C10	Same as A8C1			
A8C11	Same as A8C1			
A8C12	Same as A8C1			
A8C13	Same as A8C1			
A8C14	Same as A8C1			
A8C15	Capacitor, Feedthru	2425-003W5UO-102AA	72982	1
A8F1	Fuse, Cartridge, 1.5 Amp, 250 V	31301-5	75915	1
A8FL1	Filter	3V3K3	05245	1
A8J1	Connector, Receptacle	166851	82199	1
A8J2	Adapter	970041-01	82199	2
A8J3	Same as A8J2			
A8L1	Coil	163419	82199	1
A8S1	Switch, 3PDT	163337	82199	1
A8W1	Cable Assembly	163322	82199	1
A8W2	Cable Assembly	163323	82199	1
A8W3	Cable Assembly	163324	82199	1
A8W4	Cable Assembly	163300	82199	1
A8W5	Cable Assembly	163495	82199	1

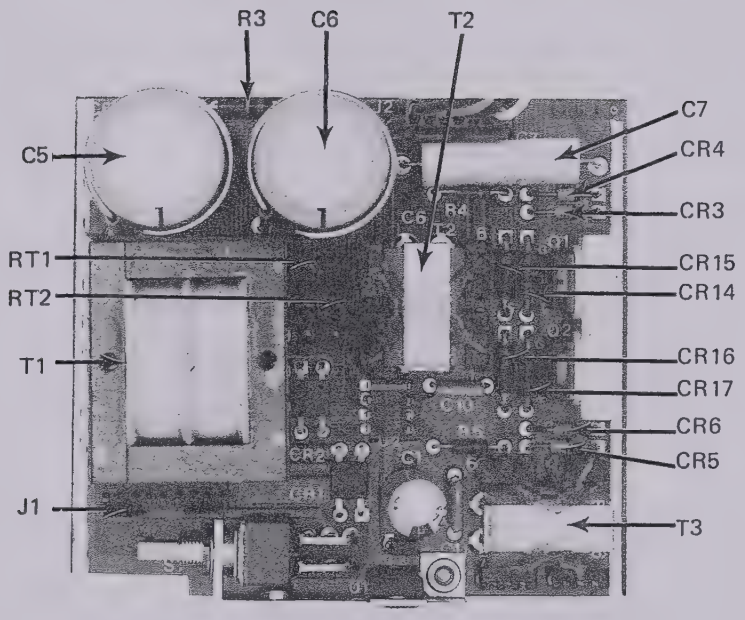

Figure 6-10. Power Supply Board Assembly A8A1, Parts Location

Section VI
Parts List

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A8A1	**POWER SUPPLY BOARD ASSEMBLY** (See Fig. 6-10)	**163188**	**82199**	**1**
A8A1C1	Capacitor, Fixed, Electrolytic, 470 UF, 35 WVDC	VTL470S35	37942	1
A8A1C2	Capacitor, Fixed, Electrolytic, 0.1 UF, 50 WVDC	CK05BX104K	81349	1
A8A1C5	Capacitor, Fixed, Electrolytic, 220 UF, 200 WVDC	LP221S200A7P3	37942	2
A8A1C6	Same as A8A1C5			
A8A1C7	Capacitor, Fixed, Plastic, 1 UF, 250 WVDC	TRW-61	84411	1
A8A1C10	Capacitor, Fixed, Ceramic, 22 UF, 50 WVDC	3C37Z5U225M050B	56289	2
A8A1C11	Same as A8A1C10			
A8A1CR1	Semiconductor Device, Diode	MDA920A2	04713	1
A8A1CR2	Semiconductor Device, Diode	MDA920A7	04713	1
A8A1CR3	Semiconductor Device, Diode	1N4747A	81349	4
A8A1CR4	Same as A8A1CR3			
A8A1CR5	Same as A8A1CR3			
A8A1CR6	Same as A8A1CR3			
A8A1CR14	Semiconductor Device, Diode	1N5388B	81349	4
A8A1CR15	Same as A8A1CR14			
A8A1CR16	Same as A8A1CR14			
A8A1CR17	Same as A8A1CR14			
A8A1J1	Connector, 9 Pin	1100-8-109-01	26742	1
A8A1J2	Connector, 7 Pin	1100-8-107-01	26742	1
A8A1Q1	Transistor	MTP4N45	04713	2
A8A1Q2	Same as A8A1Q1			
A8A1R1	Resistor, Fixed, WW, 0.55 Ohms, 1%,1W	RW81UR550F	81349	1
A8A1R2	Resistor, Fixed, Composition, 100K, 5%, ½W	RC20GF104J	81349	2
A8A1R3	Same as A8A1R2			
A8A1R4	Resistor, Fixed, Composition, 22 Ohms, 5%, ¼W	RC07GF220J	81349	2
A8A1R5	Same as A8A1R4			
A8A1RT1	Thermistor	CL-70	91873	2
A8A1RT2	Same as A8A1RT1			
A8A1S1	Switch	8261AV2	09353	1
A8A1T1	Transformer	DST-4-36	08779	1
A8A1T2	Transformer	163226	82199	2
A8A1T3	Same as A8A1T2			
A8A1U1	Integrated Circuit	MC78M12CT	04713	1
A8A1U2	Integrated Circuit	MMH0026CL	04713	1

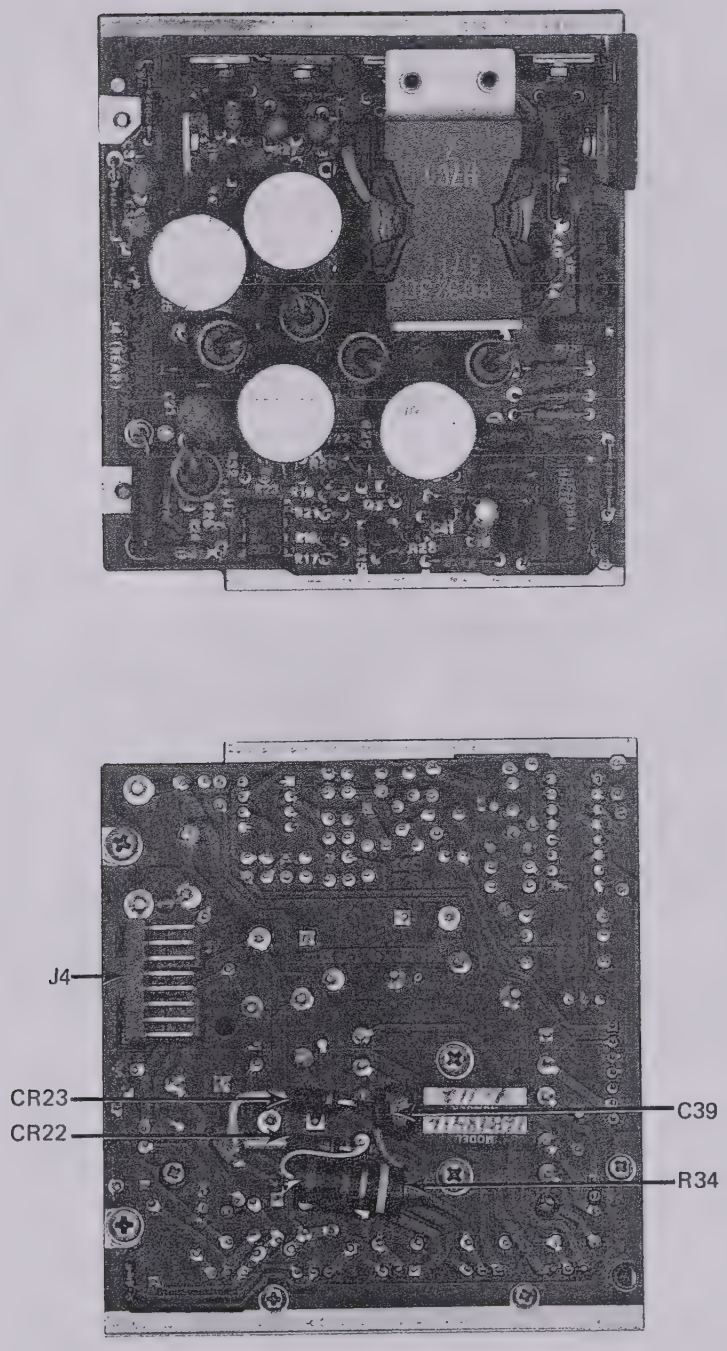

Figure 6-11. Power Supply Board Assembly A8A2, Parts Location

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A8A2	**POWER SUPPLY BOARD ASSEMBLY (See Fig. 6-11)**	**163189**	**82199**	**1**
A8A2C14	Capacitor, Fixed, Plastic, 0.01 UF, 400 WVDC	PMG-100-400V	61449	1
A8A2C15	Capacitor, Fixed, Ceramic, 0.1 UF, 50 WVDC	CK05BX104K	81349	5
A8A2C17	Capacitor, Fixed, Mica, 0.001 UF, 100 WVDC	CM05FA102J03	81349	1
A8A2C18	Capacitor, Fixed, Electrolytic, 2.2 UF, 63 WVDC	503D225M063KA	56289	1
A8A2C20	Capacitor, Fixed, Electrolytic, 1000 UF, −10 + 30%, 25 WVDC	ECE-A1EF102R	S5175	4
A8A2C21	Capacitor, Fixed, Electrolytic, 150 UF, 15 WVDC	196D157X9015TE4	56289	1
A8A2C22	Same as A8A2C20			
A8A2C24	Same as A8A2C15			
A8A2C25	Same as A8A2C20			
A8A2C27	Same as A8A2C15			
A8A2C28	Same as A8A2C20			
A8A2C30	Same as A8A2C15			
A8A2C31	Capacitor, Fixed, Ceramic, 0.001 UF, 1000 WVDC	DD-102	71590	4
A8A2C32	Same as A8A2C31			
A8A2C33	Same as A8A2C31			
A8A2C34	Capacitor, Fixed, Ceramic, 10 UF, 35 WVDC	199D106X9035DB1	56289	5
A8A2C35	Same as A8A2C34			
A8A2C36	Same as A8A2C34			
A8A2C37	Same as A8A2C34			
A8A2C38	Same as A8A2C34			
A8A2C39	Capacitor, Fixed, Mica, 330 PF, 100 WVDC	CM04FA331J03	81349	1
A8A2C40	Same as A8A2C31			
A8A2C41	Same as A8A2C15			
A8A2C42	Capacitor, Fixed, Mica, 560 PF, 300 WVDC	CM05FC561J03	81349	2
A8A2C43	Same as A8A2C42			
A8A2C44	Capacitor, Fixed, Mica, 270 PF, 500 WVDC	CM04FC271JP3	81349	1
A8A2CR7	Semiconductor Device Diode	VSK14	62703	1
A8A2CR8	Semiconductor Device, Diode	UES2402	12969	3
A8A2CR9	Same as A8A2CR8			
A8A2CR10	Same as A8A2CR8			
A8A2CR11	Semiconductor Device, Diode	1N4002	81349	6
A8A2CR12	Same as A8A2CR11			
A8A2CR13	Same as A8A2CR11			
A8A2CR18	Semiconductor Device, Diode	1N4733A	81349	1
A8A2CR19	Same as A8A2CR11			
A8A2CR20	Same as A8A2CR11			
A8A2CR21	Same as A8A2CR11			
A8A2CR22	Semiconductor Device, Diode	1N5382B	81349	2
A8A2CR23	Same as A8A2CR22			
A8A2J3	Connector, 7 Pin	1100-8-107-01	26472	1
A8A2J4	Connector, 8 Pin	1100-9-108-01	26472	1
A8A2L1	Coil, RF	163230	82199	5
A8A2L2	Same as A8A2L1			
A8A2L3	Same as A8A2L1			
A8A2L5	Same as A8A2L1			
A8A2L7	Same as A8A2L1			
A8A2R8	Resistor, Fixed, Composition, 560 Ohms, 5%, ¼W	RC07GF561J	81349	1

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A8A2R9	Resistor, Fixed, Film, 2.74K, 1%, 1/8W	RN55D2741F	81349	1
A8A2R10	Resistor, Fixed, Film, 10K, 1%, 1/8W	RN55D1002F	81349	4
A8A2R11	Same as A8A2R10			
A8A2R12	Same as A8A2R10			
A8A2R13	Resistor, Variable, 1K	RJ24FX102F	81349	1
A8A2R14	Same as A8A2R10			
A8A2R15	Resistor, Fixed, Composition, 100 Ohms, 5%, ¼W	RC07GF101J	81349	2
A8A2R16	Resistor, Fixed, WW, 0.01 UF, 1%, 3W	LO-3 .01 1%	77342	1
A8A2R17	Resistor, Fixed, Composition, 1K, 5%, ¼W	RC07GF102J	81349	2
A8A2R18	Same as A8A2R17			
A8A2R19	Resistor, Fixed, Film, 1.3K, 1%, 1/8W	RN55D1301F	81349	3
A8A2R20	Same as A8A2R19			
A8A2R21	Same as A8A2R19			
A8A2R22	Thermistor, 1K, 1%	TD-551K1%	84411	1
A8A2R23	Resistor, Fixed, Film, 1.1K, 1%, 1/8W	RN55D1101F	81349	2
A8A2R24	Same as A8A2R23			
A8A2R25	Resistor, Fixed, Film, 49.9K, 1%, 1/8W	RN55D4992F	81349	1
A8A2R26	Resistor, Variable, 500 Ohms	RJ24FW501F	81349	1
A8A2R27	Resistor, Fixed, Film, 1.69K, 1%, 1/8W	RN55D1691F	81349	1
A8A2R28	Same as A8A2R15			
A8A2R29	Resistor, Fixed, Composition, 22 Ohms, 5%, ¼W	RC07GF220J	81349	1
A8A2R30	Resistor, Fixed, Film, 604 Ohms, 1%, 1/8W	RN55D6040F	81349	1
A8A2R31	Resistor, Fixed, Composition, 10K, 5%, ¼W	RC07GF103J	81349	1
A8A2R32	Resistor, Fixed, Composition, 1M, 5%, ¼W	RC07GF105J	81349	1
A8A2R33	Resistor, Fixed, Film, 10K, 1%, 1/8W	RN55D1002F	81349	1
A8A2R34	Resistor, Fixed, Film, 100 Ohms, 5%, 2W	RC42GF101J	81349	1
A8A2R35	Resistor, Fixed, Film, 37.4 Ohms, 1%, 1/8W	RN55D37R4F	81349	1
A8A2T4	Transformer	163232	82199	1
A8A2U3	Integrated Circuit	SG2525SAJ	18326	1
A8A2U4	Integrated Circuit	LM317T	04713	1
A8A2U5	Integrated Circuit	78T15ACT	04713	1
A8A2U6	Integrated Circuit	MC7915CT	04713	1
A8A2U7	Integrated Circuit	LM2904N	36482	1
A8A2Q3	Transistor	2N4400	81349	2
A8A2Q4	Same as A8A2Q3			

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A9	**FRONT PANEL ASSEMBLY**	**163247**	**82199**	**1**
A9A1	Microprocessor Board Assembly	163101	82199	1
A9A2	Display Board Assembly	163063	82199	1
A9J1	Connector, RF	163515-1	82199	1
A9J2	Connector, RF	163515-2	82199	3
A9J3	Same as A9J2			
A9J4	Same as A9J2			
A9W2	Cable Assembly	163305-1	82199	1
A9W3	Cable Assembly	163305-2	82199	1

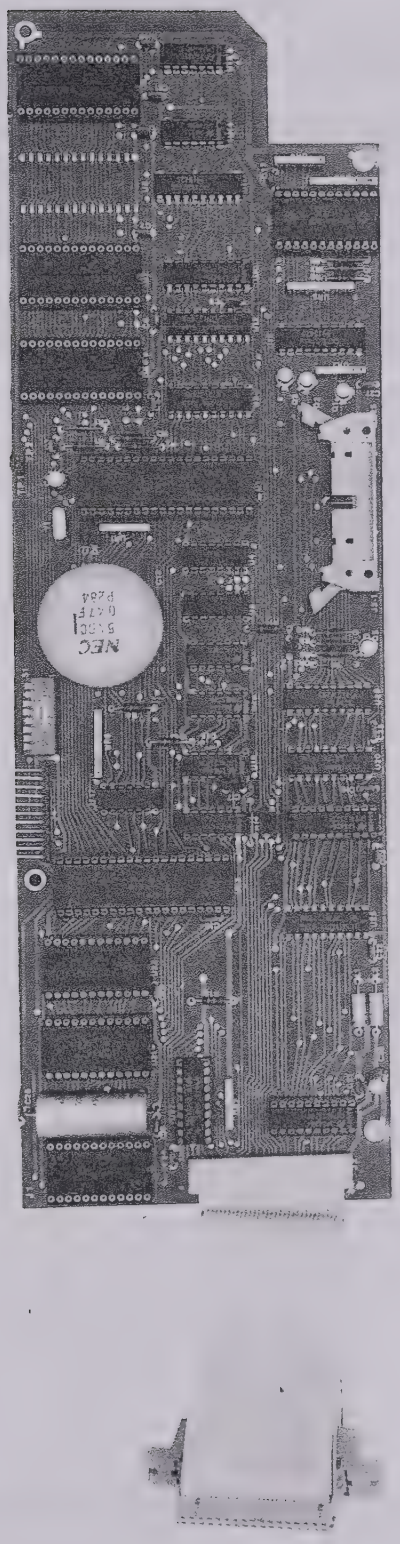

Figure 6-12. Microprocessor Board Assembly A9A1, Parts Location

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A9A1	**MICROPROCESSOR BOARD ASSEMBLY (See Fig. 6-12)**	**163101**	**82199**	**1**
A9A1C1	Capacitor, Fixed, Ceramic, 20 PF, 500 WVDC	801-000-C0C0200J	59660	2
A9A1C2	Same as A9A1C1			
A9A1C3	Capacitor, Fixed, Ceramic, 0.1 UF	CK05BX104K	81349	18
A9A1C4	Capacitor, Fixed, Electrolytic, 10 UF, 35 WVDC	VTL10S35	37942	2
A9A1C5	Same as A9A1C3			
A9A1C6	Same as A9A1C3			
A9A1C7	Same as A9A1C3			
A9A1C8	Same as A9A1C3			
A9A1C9	Same as A9A1C3			
A9A1C10	Same as A9A1C3			
A9A1C11	Same as A9A1C3			
A9A1C12	Capacitor, Fixed, Ceramic, 0.01 UF	CK05BX103K	81349	1
A9A1C13	Capacitor, Fixed, 0.47 UF, 5 WVDC	FAOH474Z	61892	1
A9A1C15	Capacitor, Fixed, Ceramic, 0.01 UF	CK05BX102K	81349	1
A9A1C16	Same as A9A1C3			
A9A1C17	Capacitor, Fixed, Mica, 330 PF, 100 WVDC	CM05FA331J03	81349	1
A9A1C18	Same as A9A1C3			
A9A1C19	Same as A9A1C3			
A9A1C20	Same as A9A1C3			
A9A1C21	Same as A9A1C3			
A9A1C22	Same as A9A1C3			
A9A1C24	Same as A9A1C3			
A9A1C25	Same as A9A1C3			
A9A1C26	Capacitor, Fixed, Electrolytic, 1000 UF, 15 WVDC	TC1501	37942	1
A9A1C27	Same as A9A1C3			
A9A1C28	Same as A9A1C4			
A9A1CR1	Semiconductor Device, Diode	1N914	81349	1
A9A1CR2	Semiconductor Device, Diode	1N5228B	81349	1
A9A1J1	Socket, Integrated Circuit	524-AG10D	91506	4
A9A1J2	Connector	1100-1-102-02	26742	1
A9A1J3	Connector	970067-02	82199	1
A9A1J4	Connector	1100-3-111-01	26742	1
A9A1J6	Same as A9A1J1			
A9A1L1	Coil, RF	1537-06	71895	2
A9A1L2	Same as A9A1L1			
A9A1Q1	Transistor	2N2369	81349	4
A9A1Q2	Same as A9A1Q1			
A9A1Q3	Same as A9A1Q1			
A9A1Q4	Transistor	2N4402	81349	1
A9A1Q5	Same as A9A1Q1			
A9A1R1	Resistor, Fixed, Composition, 22K, 5%, ¼W	RC07GF223J	81349	1
A9A1R2	Resistor, Fixed, Composition, 2K, 5%, ¼W	RC07GF202J	81349	2
A9A1R3	Same as A9A1R3			
A9A1R4	Resistor, Fixed, Composition, 1K 5%, ¼W	RC07GF102J	81349	4
A9A1R5	Resistor, Fixed, Composition, 10K, 5%, ¼W	RC07GF103J	81349	5
A9A1R6	Same as A9A1R5			
A9A1R7	Same as A9A1R5			
A9A1R8	Same as A9A1R4			

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A9A1R9	Same as A9A1R4			
A9A1R10	Same as A9A1R4			
A9A1R11	Resistor, Fixed, Composition, 10 Ohms, 5%, ¼W	RC07GF100J	81349	1
A9A1R13	Same as A9A1R5			
A9A1R14	Resistor, Fixed, Composition, 12K, 5%, ¼W	RC07GF123J	81349	1
A9A1R15	Same as A9A1R5			
A9A1S1	Switch, SPST, 8 Pos.	76PSB08S	81073	1
A9A1U1	Integrated Circuit	P8085AH-2	34649	1
A9A1U2	Integrated Circuit	SN74LS244N	01295	5
A9A1U3	Integrated Circuit	DM74LS32N	36482	1
A9A1U4	Integrated Circuit	SN74LS138N	01295	2
A9A1U5	Same as A9A1U4			
A9A1U6	Integrated Circuit	D27128	34649	2
A9A1U7	Same as A9A1U6			
A9A1U9	Integrated Circuit	D2764-3	34649	1
A9A1U10	Integrated Circuit	SN74LS373N	01295	3
A9A1U11	Integrated Circuit	SN74LS245N	01295	3
A9A1U12	Same as A9A1U2			
A9A1U13	Integrated Circuit	SN7407N	01295	2
A9A1U14	Same as A9A1U13			
A9A1U15	Same as A9A1U11			
A9A1U16	Integrated Circuit	HM6116P-4	62786	1
A9A1U17	Integrated Circuit	SN74LS74AN	01295	1
A9A1U18	Integrated Circuit	SN74LS04N	01295	1
A9A1U19	Integrated Circuit	SN74LS123N	01295	1
A9A1U20	Same as A9A1U2			
A9A1U21	Integrated Circuit	MC3447P	04713	2
A9A1U22	Same as A9A1U21			
A9A1U23	Integrated Circuit	P8291A	34649	1
A9A1U24	Same as A9A1U10			
A9A1U25	Same as A9A1U2			
A9A1U26	Same as A9A1U10			
A9A1U27	Same as A9A1U2			
A9A1U28	Integrated Circuit	SN74LS08N	01295	1
A9A1U29	Same as A9A1U11			
A9A1UR1	Resistor Network	750-61-R102	11237	1
A9A1UR2	Resistor Network	750-61-R103	11237	3
A9A1UR3	Resistor Network	750-81-R103	11237	3
A9A1UR4	Same as A9A1UR2			
A9A1UR5	Same as A9A1UR3			
A9A1UR6	Same as A9A1YR3			
A9A1UR7	Same as A9A1UR3			
A9A1UX1	Socket, Integrated Circuit	540-AG10D	91506	2
A9A1UX6	Socket, Integrated Circuit	528-AG10D	91506	3
A9A1UX7	Same as A9A1UX6			
A9A1UX9	Same as A9A1UX6			
A9A1UX21	Same as A9A1J1			
A9A1UX22	Same as A9A1J1			
A9A1UX23	Same as A9A1UX1			
A9A1UX24	Socket, Integrated Circuit	520-AG10D	91506	3

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A9A1UX26	Same as A9A1UX24			
A9A1UX27	Same as A9A1UX24			
A9A1W1	Cable	163228	82199	1
A9A1Y1	Crystal	MP101,H3W	11237	1

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A9A2	**DISPLAY BOARD ASSEMBLY (See Fig. 6-13)**	**163063**	**82199**	**1**
A9A2C1	Capacitor, Fixed, Electrolytic, 1000 UF, 16 WVDC	VTL1000S16A	37942	1
A9A2C2	Capacitor, Fixed, Ceramic, 0.1 UF, 50 WVDC	CK04BX104K	81349	2
A9A2C3	Capacitor, Fixed, Electrolytic, 10 UF, 35 WVDC	VTL10S35	37942	2
A9A2C4	Same as A9A2C3			
A9A2C5	Capacitor, Fixed, Mica, 36 PF, 500 WVDC	CM04ED360J03	81349	1
A9A2C6	Same as A9A2C2			
A9A2DG1	Indicator, Numeric	5082-7610	28480	12
A9A2DG2	Same as A9A2DG1			
A9A2DG3	Same as A9A2DG1			
A9A2DG4	Same as A9A2DG1			
A9A2DG5	Same as A9A2DG1			
A9A2DG6	Same as A9A2DG1			
A9A2DG7	Same as A9A2DG1			
A9A2DG8	Same as A9A2DG1			
A9A2DG9	Same as A9A2DG1			
A9A2DG10	Same as A9A2DG1			
A9A2DG11	Same as A9A2DG1			
A9A2DG12	Same as A9A2DG1			
A9A2DG13	Indicator, Numeric	5082-7414	28480	3
A9A2DG14	Same as A9A2DG13			
A9A2DG15	Same as A9A2DG13			
A9A2DS1	Light Emitting Diode	5082-4684	28480	30
A9A2DS2	Same as A9A2DS1			
A9A2DS3	Same asA9A2DS1			
A9A2DS4	Same as A9A2DS1			
A9A2DS5	Same as A9A2DS1			
A9A2DS6	Same as A9A2DS1			
A9A2DS7	Same as A9A2DS1			
A9A2DS8	Same as A9A2DS1			
A9A2DS9	Same as A9A2DS1			
A9A2DS10	Same as A9A2DS1			
A9A2DS11	Same as A9A2DS1			
A9A2DS12	Same as A9A2DS1			
A9A2DS13	Same as A9A2DS1			
A9A2DS14	Same as A9A2DS1			
A9A2DS15	Same as A9A2DS1			
A9A2DS16	Same as A9A2DS1			
A9A2DS17	Same as A9A2DS1			
A9A2DS18	Same as A9A2DS1			
A9A2DS19	Same as A9A2DS1			
A9A2DS20	Same as A9A2DS1			
A9A2DS21	Same as A9A2DS1			
A9A2DS22	Same as A9A2DS1			
A9A2DS23	Same as A9A2DS1			
A9A2DS24	Same as A9A2DS1			
A9A2DS25	Same as A9A2DS1			
A9A2DS26	Same as A9A2DS1			
A9A2DS27	Same as A9A2DS1			
A9A2DS28	Same as A9A2DS1			

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A9A2DS29	Same as A9A2DS1			
A9A2DS30	Same as A9A2DS1			
A9A2Q1	Transistor	UGN3040T	56289	2
A9A2Q2	Same as A9A2Q1			
A9A2R1	Resistor, Fixed, Composition, 47 Ohms, 5%, ¼W	RC07GF470J	81349	1
A9A2R9	Resistor, Fixed, Composition, 10K, 5%, ¼W	RC07GF103J	81349	3
A9A2R10	Same as A9A2R9			
A9A2R11	Same as A9A2R9			
A9A2S1	Switch	163374-7	82199	1
A9A2S2	Switch	163374-8	82199	1
A9A2S3	Switch	163374-9	82199	1
A9A2S4	Switch	163375-2	82199	1
A9A2S5	Switch	163374-4	82199	1
A9A2S6	Switch	163374-5	82199	1
A9A2S7	Switch	163374-6	82199	1
A9A2S8	Switch	163375-1	82199	1
A9A2S9	Switch	163374-1	82199	1
A9A2S10	Switch	163374-2	82199	1
A9A2S11	Switch	163374-3	82199	1
A9A2S12	Switch	163374-13	82199	1
A9A2S13	Switch	163374-10	82199	1
A9A2S14	Switch	163374-11	82199	1
A9A2S15	Switch	163374-12	82199	1
A9A2S16	Switch	163375-3	82199	1
A9A2S17	Switch	163377-10	82199	1
A9A2S18	Switch	163377-1	82199	1
A9A2S19	Switch	163377-2	82199	1
A9A2S20	Switch	163377-3	82199	1
A9A2S21	Switch	163377-4	82199	1
A9A2S22	Switch	163377-5	82199	1
A9A2S23	Switch	163377-6	82199	1
A9A2S24	Switch	163377-7	82199	1
A9A2S25	Switch	163377-8	82199	1
A9A2S26	Switch	163376-1	82199	1
A9A2S27	Switch	163377-9	82199	1
A9A2S28	Switch, Push	34-550-011	10389	2
A9A2S29	Same as A9A2S28			
A9A2S30	Switch, Key	960013-01	82199	2
A9A2S31	Same as A9A2S30			
A9A2U1	Integrated Circuit	MPQ2907	04713	5
A9A2U2	Same as A9A2U1			
A9A2U3	Same as A9A2U1			
A9A2U4	Same as A9A2U1			
A9A2U5	Same as A9A2U1			
A9A2U6	Integrated Circuit	SN757498N	01295	5
A9A2U7	Same as A9A2U6			
A9A2U8	Same as A9A2U6			
A9A2U9	Same as A9A2U6			
A9A2U10	Same as A9A2U6			
A9A2U11	Integrated Circuit	CD4514BE	49671	2

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A9A2U12	Integrated Circuit	P8279-5	34649	2
A9A2U13	Same as A9A2U11			
A9A2U14	Integrated Circuit	CD4070AE	49671	1
A9A2U15	Same as A9A2U12			
A9A2U16	Integrated Circuit	SN74LS138N	01295	1
A9A2UR1	Resistor Network	750-83-R47OHMS	11237	9
A9A2UR2	Same as A9A2UR1			
A9A2UR3	Same as A9A2UR1			
A9A2UR4	Same as A9A2UR1			
A9A2UR5	Same as A9A2UR1			
A9A2UR6	Resistor Network	750-81-R1K	11237	1
A9A2UR7	Resistor Network	750-61-R1K	11237	3
A9A2UR8	Same as A9A2UR1			
A9A2UR9	Same as A9A2UR1			
A9A2UR10	Same as A9A2UR1			
A9A2UR11	Same as A9A2UR1			
A9A2UR12	Same as A9A2UR7			
A9A2UR13	Same as A9A2UR7			
A9A2W1	Cable	163229	82199	1

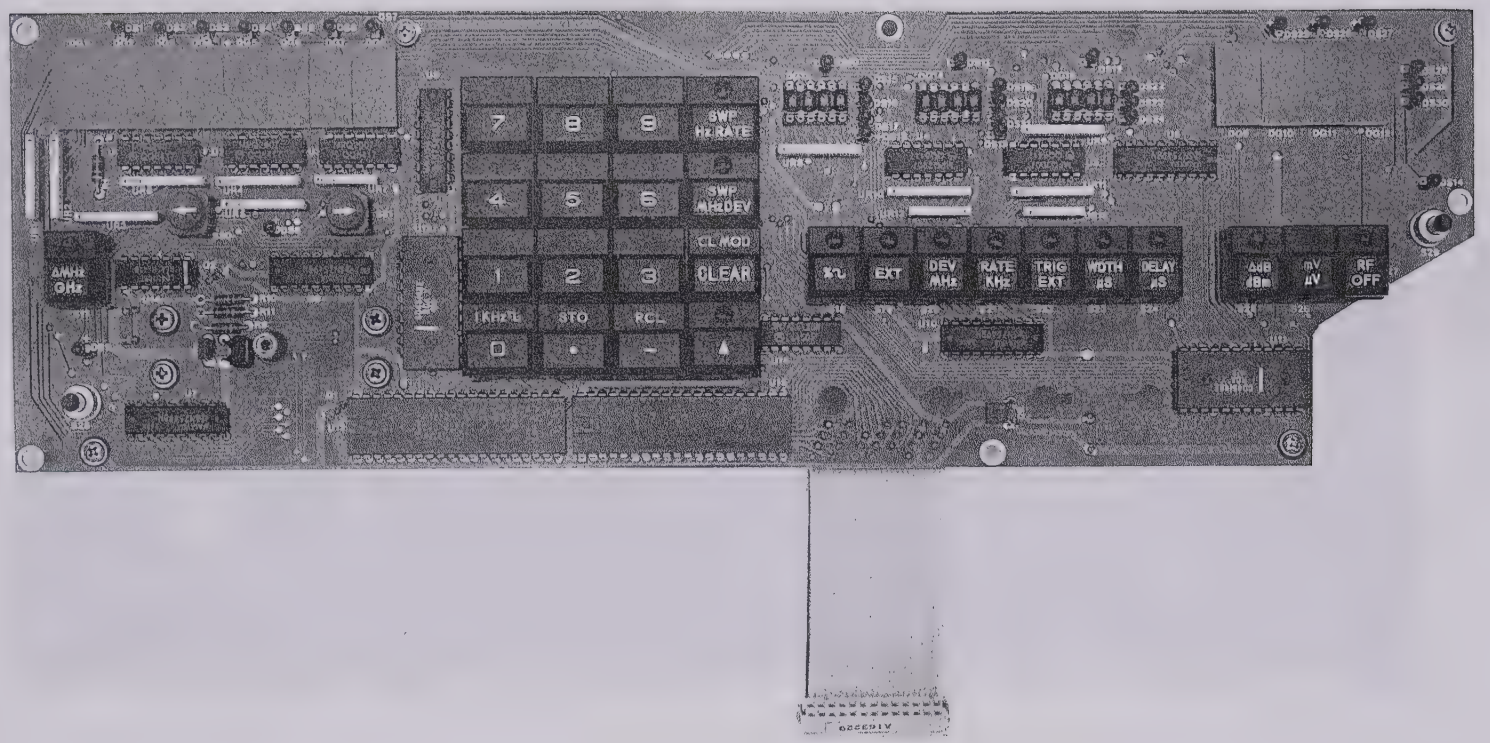

Figure 6-13. Display Board Assembly A9A2, Parts Location (Sheet 1 of 2)

Figure 6-13. Display Board Assembly A9A2, Parts Location (Sheet 2 of 2)

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A11	RF MODULE ASSEMBLY NOTE NON-REPAIRABLE ASSEMBLY. MUST BE RETURNED TO MANUFACTURER FOR REPAIR AND RECALIBRATION.	163291	82199	1

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A12	**FILTER BOARD ASSEMBLY (See Fig. 6-14)**	**163463**	**82199**	**1**
A12C1	Capacitor, Fixed, Electrolytic, 1000 UF, 25 WVDC	TC2510A	37942	2
A12C2	Same as A12C1			
A12R1	Resistor, Fixed, Composition, 10 Ohms, 5%, 2W	RC42GF100J	81349	1
A12W1	Harness Assembly	163466	82199	1

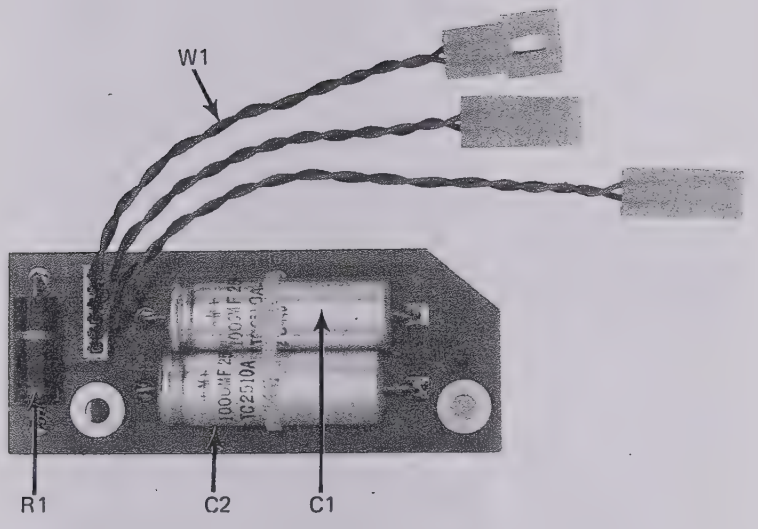

Figure 6-14. Filter Board Assembly A12, Parts Location

TABLE 6-2. PARTS LIST

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	QTY
A14	**TIME BASE ASSEMBLY (See Fig. 6-15)**	**163454**	**82199**	**1**
A14C1	Capacitor, Fixed, Electrolytic, 10 UF, 35 WVDC	VTL10S35	37942	2
A14C2	Capacitor, Fixed, Ceramic, 0.01 UF, 100 WVDC	RPE110Z5U103M	72982	3
A14C3	Same as A14C2			
A14C4	Same as A14C1			
A14C5	Capacitor, Fixed, Ceramic, 0.1 UF, 100 WVDC	RPE121Z5U104M	72982	2
A14C6	Same as A14C2			
A14C7	Same as A14C5			
A14J1	Connector	1100-12-103-01	26742	1
A14J2	Connector	970074-01	82199	1
A14Q1	Transistor	2N4400	81349	2
A14Q2	Same as A14Q1			
A14R1	Resistor, Fixed, Film, 1K, 1%, 1/8W	RN55D1001F	81349	3
A14R2	Same as A14R1			
A14R3	Resistor, Fixed, Film, 10K, 1%, 1/8W	RN55D1002F	81349	1
A14R4	Same as A14R1			
A14R5	Resistor, Fixed, Film, 2.21K, 1%, 1/8W	RN55D2211F	81349	1
A14R8	Resistor, Fixed, Film, 681 Ohms, 1%, 1/8W	RN55D6810F	81349	1
A14U1	Integrated Circuit	SN7400SN	01295	1
A14W1	Cable	163526	82199	1
	Crystal Oscillator	163281	82199	1

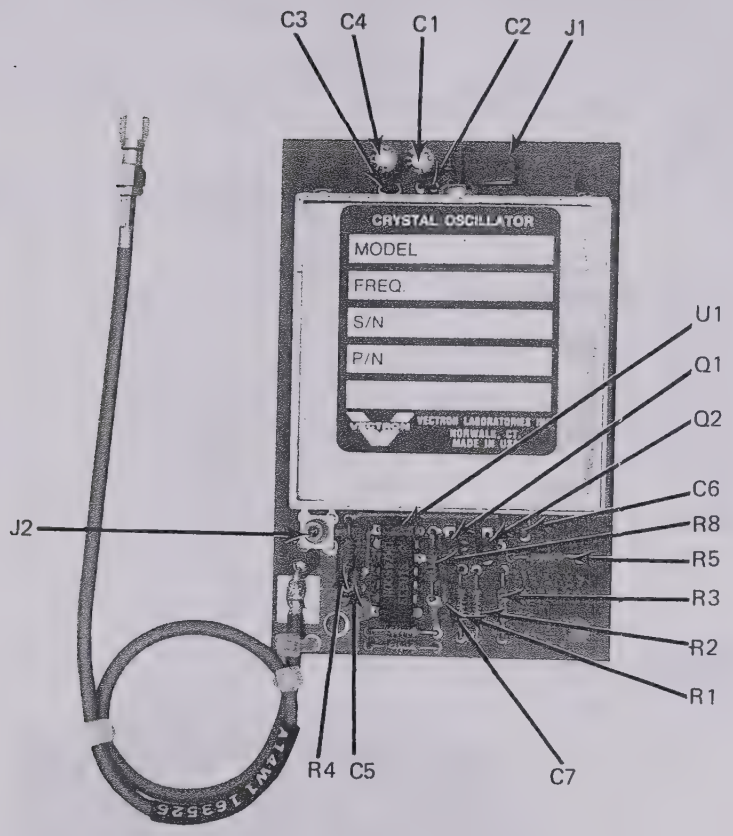

Figure 6-15. Time Base Assembly A14, Parts Location

SECTION VII

SCHEMATIC DIAGRAMS

7-1. GENERAL

7-2. This section contains the schematic diagrams (Figures 7-1 through 7-11) that are essential aids in the maintenance of Synthesized Signal Generator Model 309. The diagrams are to be used in conjunction with Sections IV and V to help the technician understand and maintain the unit. Parts location illustrations are located in Section VI.

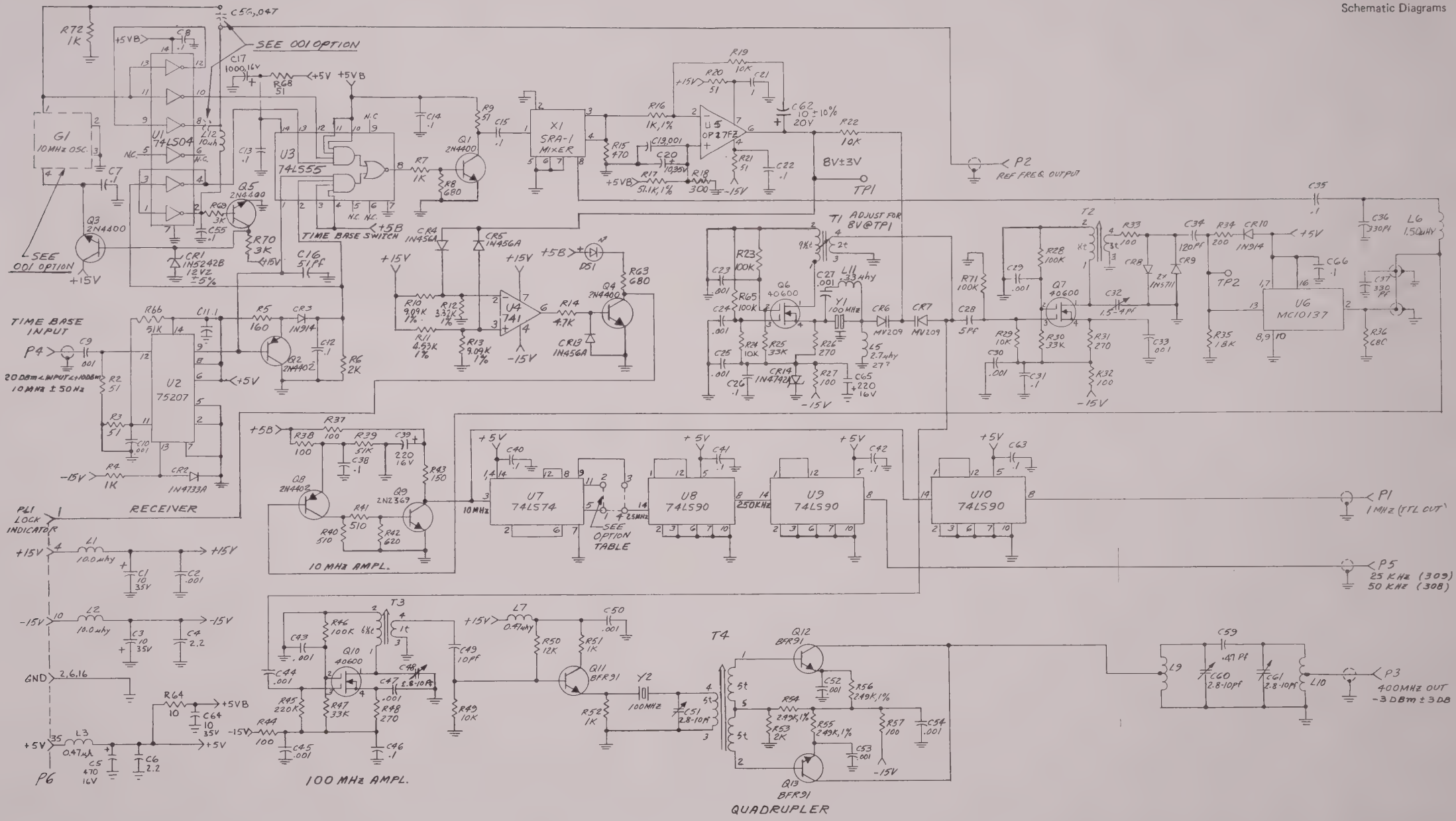

Figure 7-1. Reference Frequency Board Assembly A1, Schematic Diagram

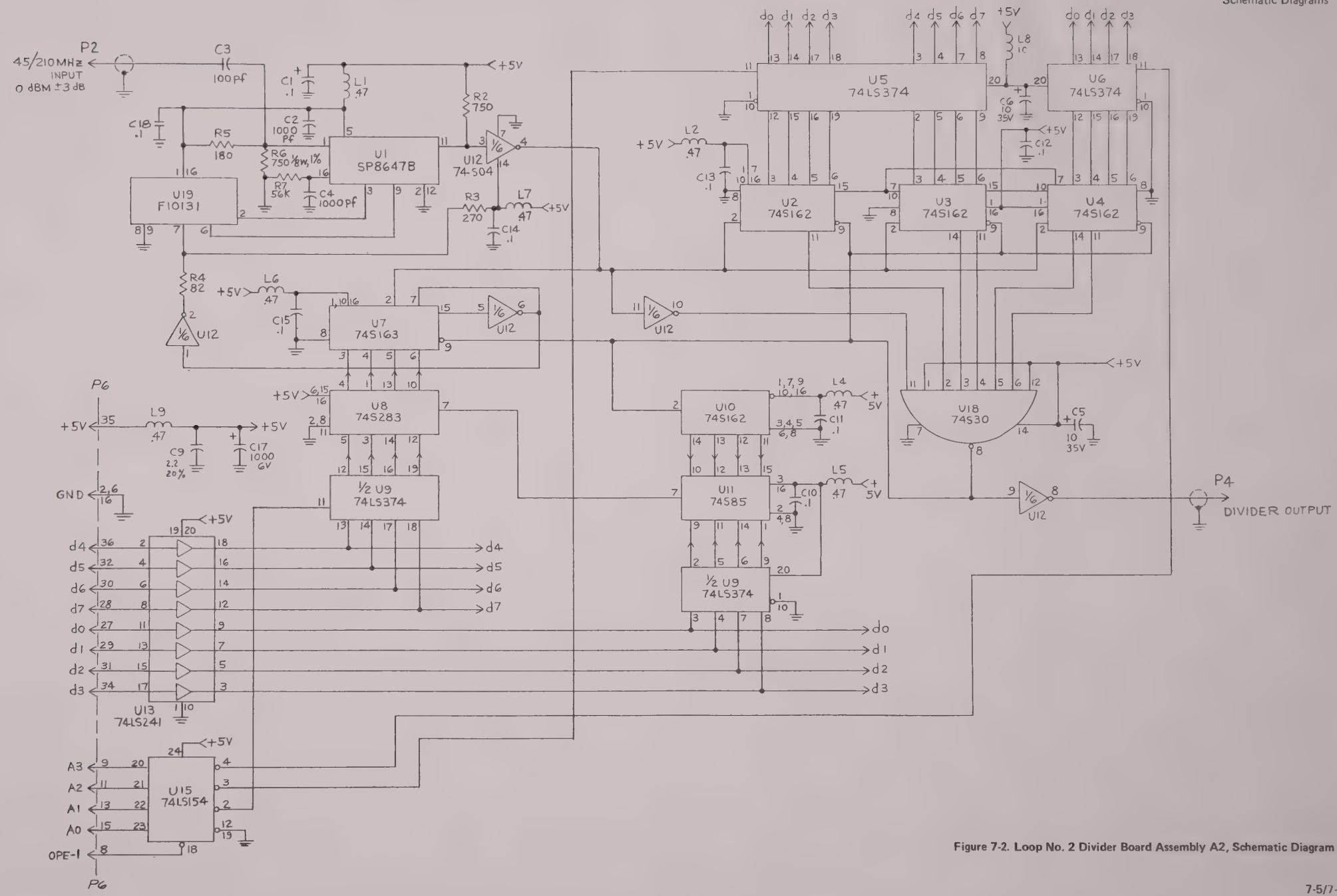

Figure 7-2. Loop No. 2 Divider Board Assembly A2, Schematic Diagram

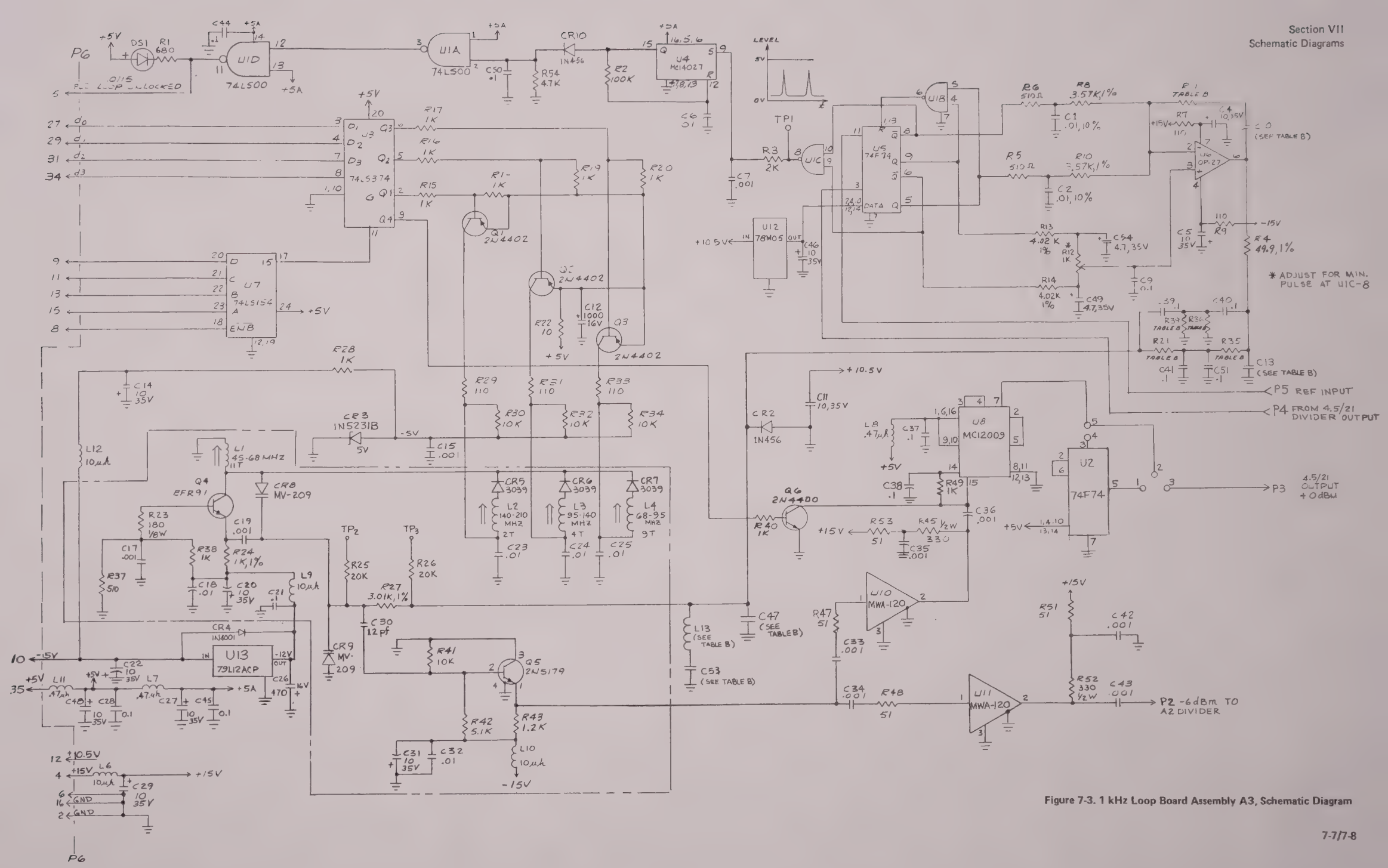

Figure 7-3. 1 kHz Loop Board Assembly A3, Schematic Diagram

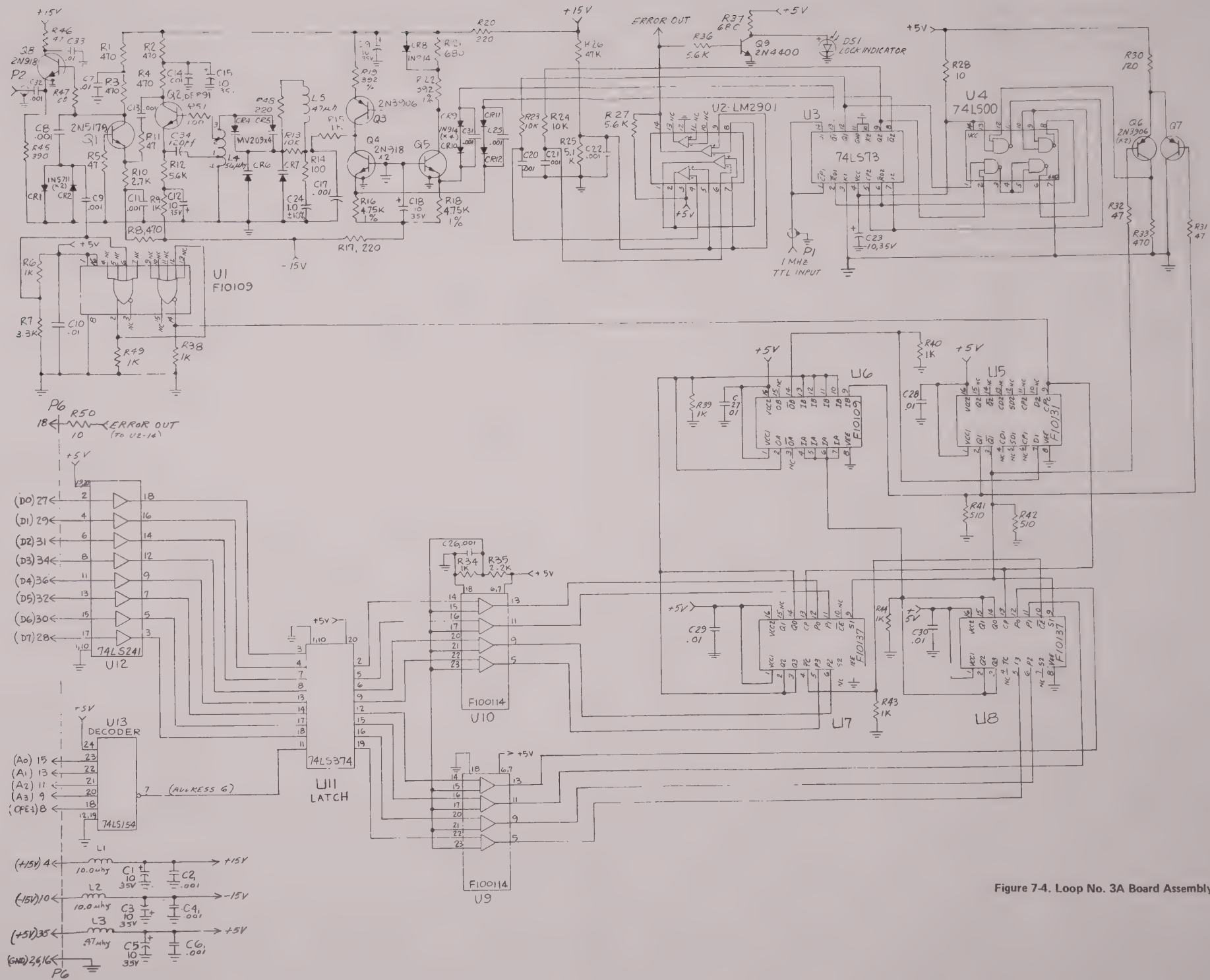

Figure 7-4. Loop No. 3A Board Assembly A4, Schematic Diagram

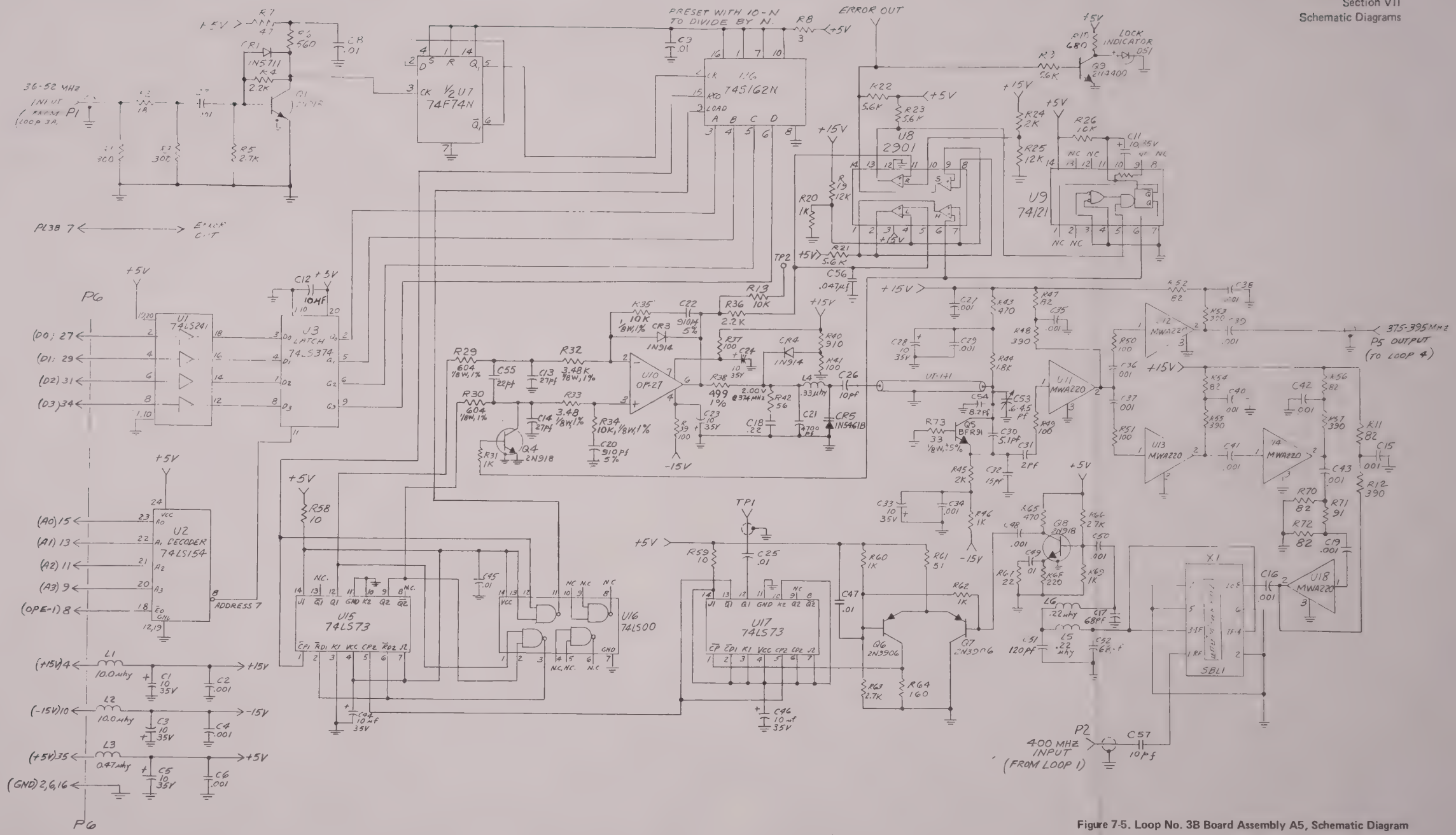

Figure 7-5. Loop No. 3B Board Assembly A5, Schematic Diagram

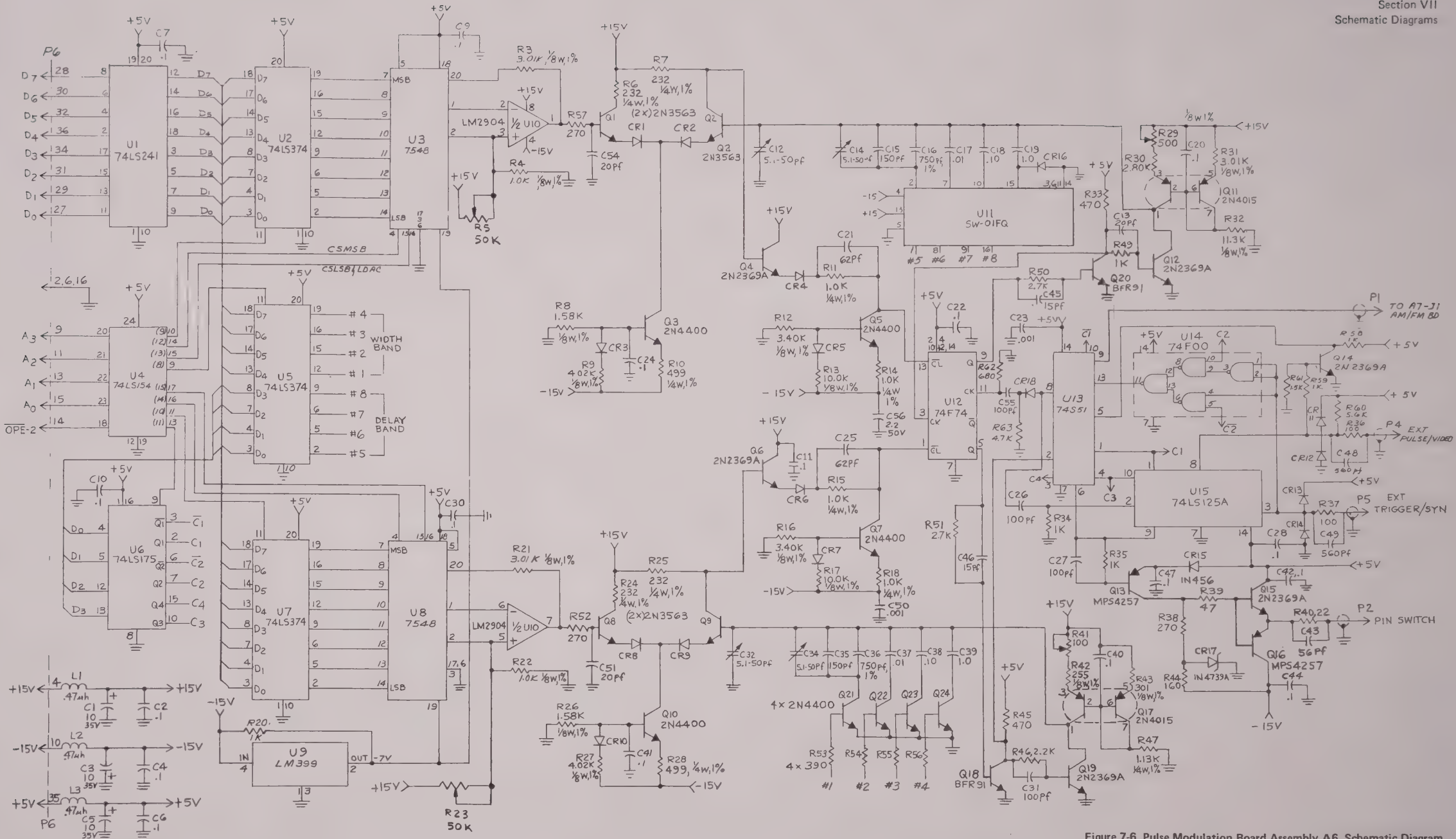

Figure 7-6. Pulse Modulation Board Assembly A6, Schematic Diagram

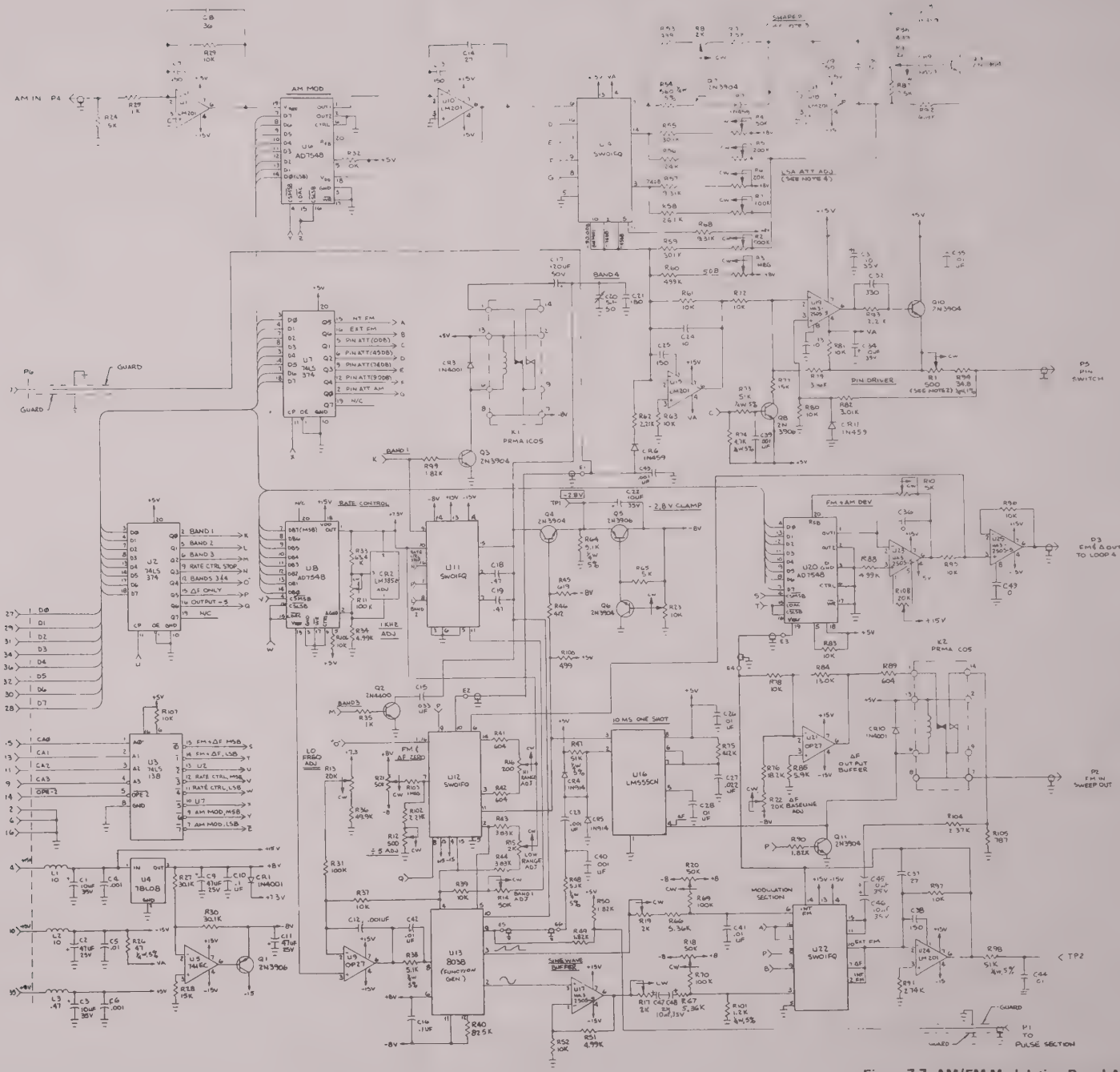

Figure 7-7. AM/FM Modulation Board Assembly A7, Schematic Diagram

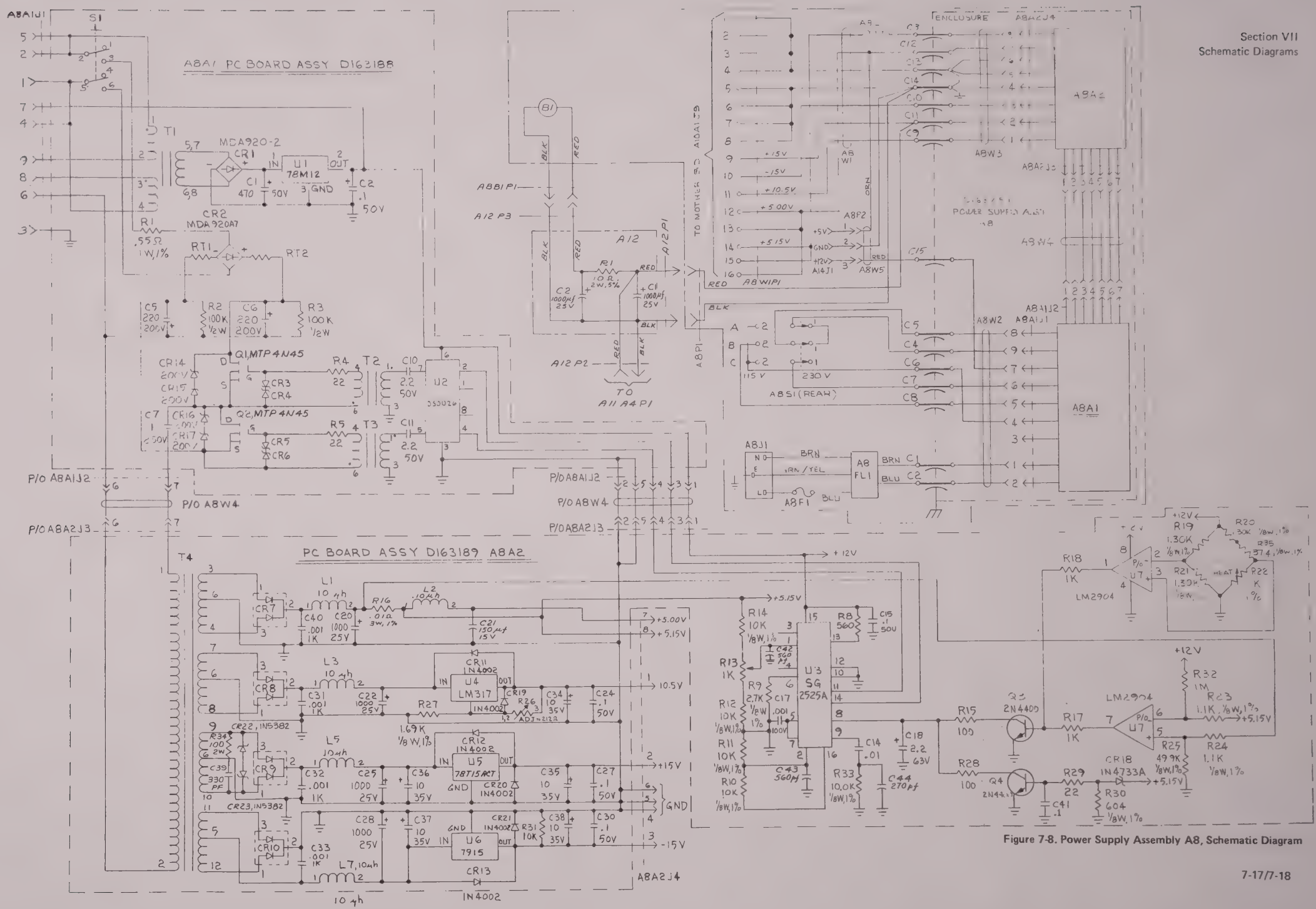

Figure 7-8. Power Supply Assembly A8, Schematic Diagram

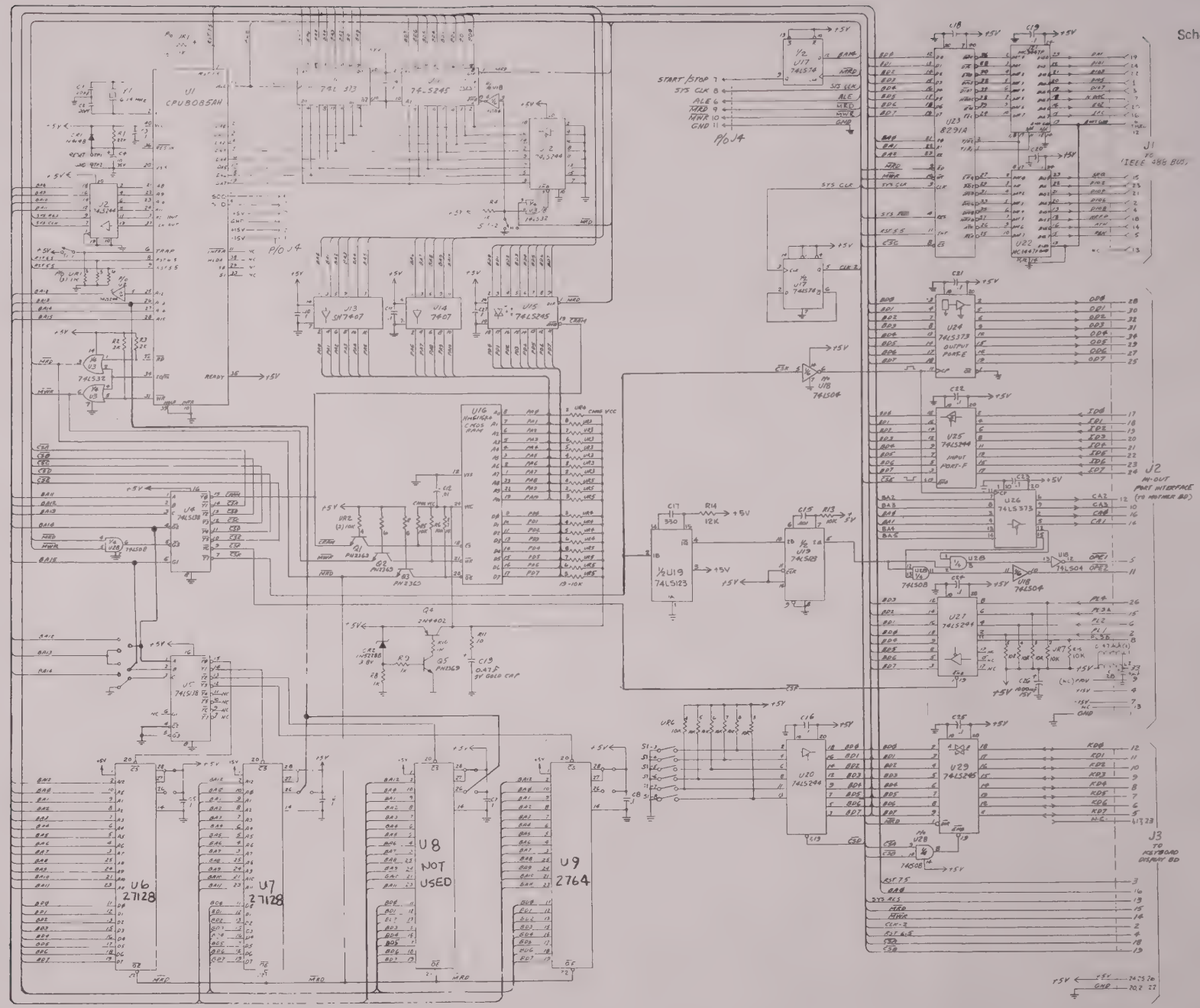

Figure 7-9. Microprocessor Board Assembly A9A1, Schematic Diagram

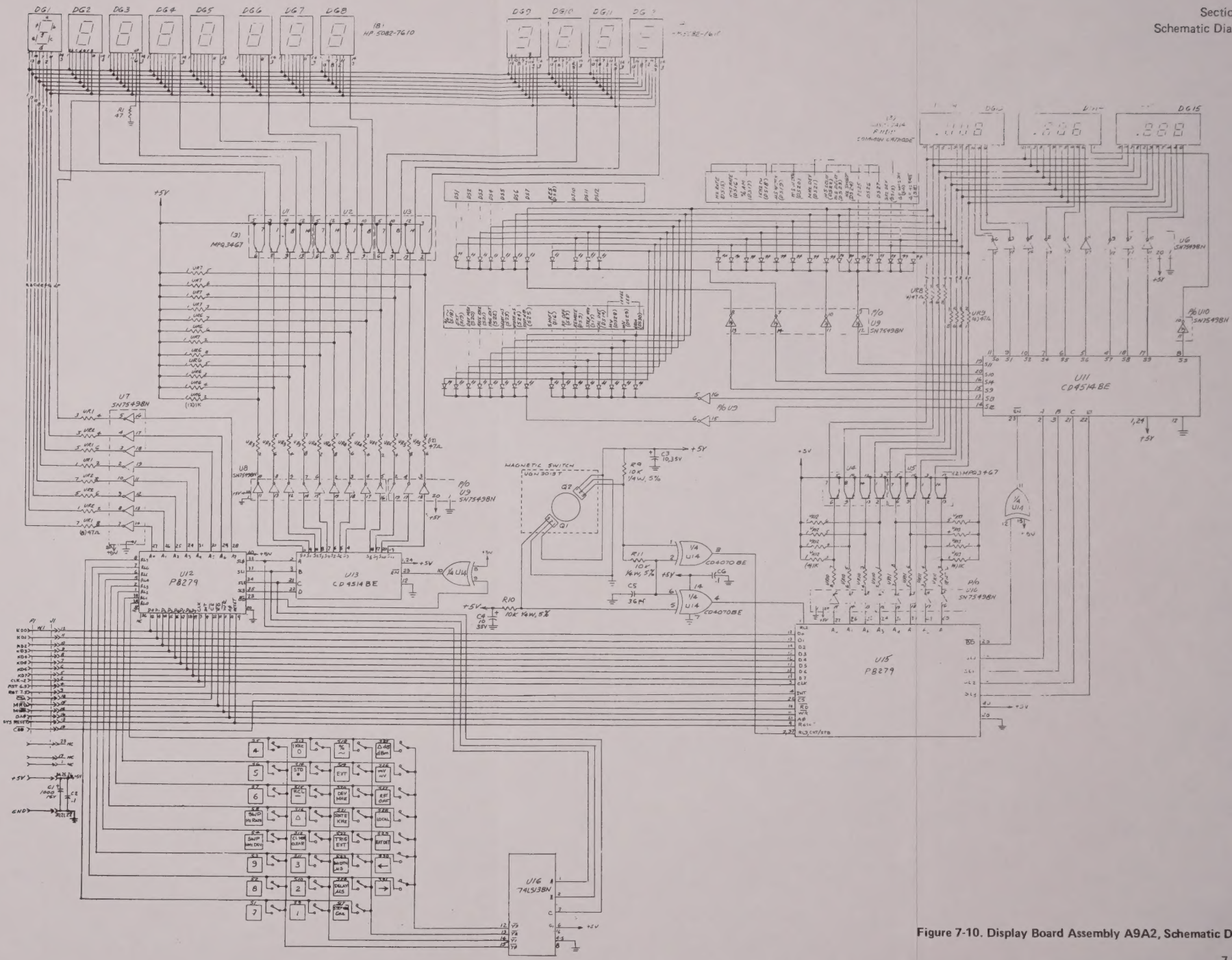

Figure 7-10. Display Board Assembly A9A2, Schematic Diagram

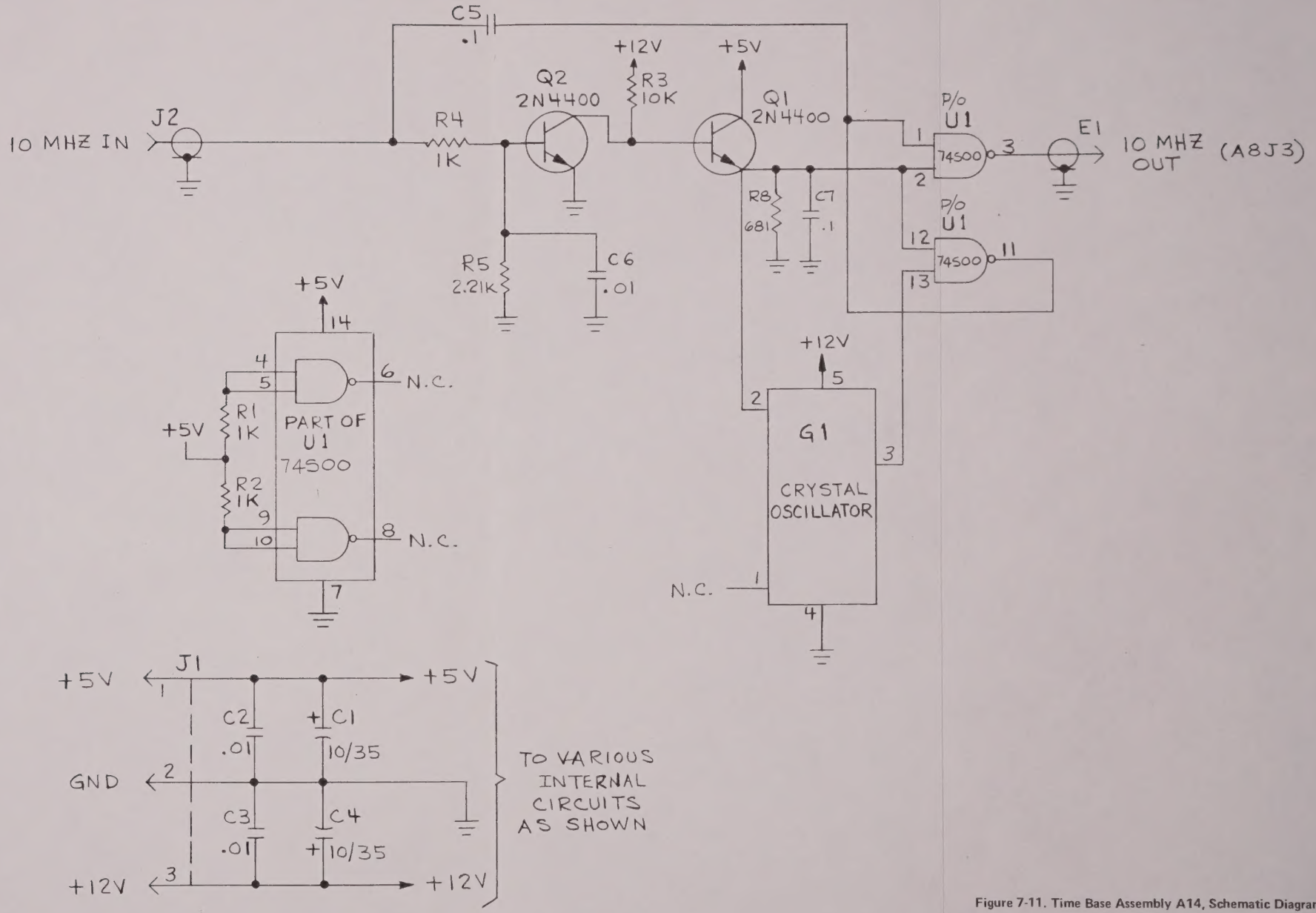

Figure 7-11. Time Base Assembly A14, Schematic Diagram